ACTA RADIOLOGICA

FOUNDED IN 1921 BY GÖSTA FORSSELL

OFFICIAL ORGAN OF THE RADIOLOGICAL SOCIETIES OF DENMARK FINLAND NORWAY AND SWEDEN

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ACTA RADIOLOGICA

OFFICIAL ORGAN OF THE RADIOLOGICAL SOCIETIES OF
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Editorial

Most periodicals devoted to radiology are of mixed contents and contain articles dealing with diagnosis and therapy as well as the physical aspects of the applications of the various kinds of radiations in the field of medicine. Articles on radiobiology have also in the past few years appeared with increasing frequency in such periodicals although this subject is in the main covered by special journals. The advantages and disadvantages of this system must necessarily be largely a matter of opinion. It is now evident, however, that with the rapid progress in radiology and with new developments and refinements of methods and techniques it is no longer possible for any one individual to master all its different branches. This applies not only to the scientific aspects but also to their application in clinical practice. To cite W. Edward Chamberlain: Surely it is not hard to discern the great difference — in temperaments, personality, training and experience — between success types in therapeutic radiology and success types in diagnostic radiology.

There is an increasing tendency in Scandinavia and England to subdivide large radiologic departments into diagnostic and therapeutic services, which means a materialization of the great expectations expressed for the future of radiology. Gösta Forssell in his opening lecture at the Fifth International Congress of Radiology stated that he believed that a complete divorce between roentgen diagnostics and radiotherapy would lead to so great advantages for research and instruction as well as for the utilization of radiology in medical practice that one of the highest hopes must be the division, as soon as possible, of the radiologic work at universities and large hospitals into separate and independent roentgendiagnostic and therapeutic departments.

It now seems that the time may be ripe for such a division to be established in the publishing field. With a view to facilitating the selection of articles for reading we have hitherto endeavoured to combine each issue of the journal in such a manner that the respective diagnostic and therapeutic articles were presented in sequence. We believe, however, that further advantages would be

gained if these, *together with their related subjects, were now to be entirely sep*arated in the monthly issues Despite the apparent divergency of opinion as to the desirability of the division into separate departments of the various branches of radiology there seems to be hardly any doubt as to the value of our readers and subscribers knowing in advance in which of the issues the respective diagnostic and therapeutic articles will be found As a consequence of these considerations the decision has now been made by the Board of Directors of Acta Ra*diologica that the journal from the beginning of 1962 will be so arranged that* one of the two annual volumes will be devoted to diagnostics and the other to therapy, physics and biology The January issue will represent Number 1 of the first volume, while the February issue will be Number 1 of the second volume of the year We thus hope to be able to represent each one of the two main fields of medical radiology in every second of the monthly issues of the journal By achieving such a division we also hope to be able to provide more space for *articles in the field of radiobiology and other relevant subjects than has hitherto* been possible To distinguish between the two series the main title of the journal (ACTA RADIOLOGICA) will be printed in two different colours, red for diagnosis and blue for therapy, physics and biology

The Editor of Acta Radiologica would like to express the hope that this rearrangement of the journal will meet with the approval of our readers He also would like to believe that by making such a decision the successors to Gosta *Forssell, the founder of Acta Radiologica, may in some measure have* contributed to a fulfillment of his ideas and intentions

Erik Lindgren

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SELECTIVE TRANSSEPTAL ANGIOCARDIOGRAPHY

by

SVEN PAULIN and EDVARDAS VARNAUSKAS

Angiocardiography with right catheterization by the selective injection of contrast medium into the left atrium is practicable only if a defect in the atrial septum or a patent foramen ovale permits passage of the catheter (8). If the atrial septum is intact, puncture of the left atrium will be required. Although retrograde catheterization of the left atrium via the aorta and left ventricle is possible, it is a difficult procedure and rarely succeeds. Selective angiocardiography of the left atrium has previously been carried out as a rule by direct puncture of the left atrium either percutaneously from behind (2, 9) or via a bronchoscope in the left main bronchus (3). The former method in particular affords satisfactory and rapid selective contrast filling of the left atrium.

Ross (1959) (13) reported a new technique for catheterization of the left heart. The method is based on transseptal puncture of the left atrium with the aid of a needle just over 70 cm long introduced via the right femoral vein. We have used this method for over six months but have found the following modification to be required for angiocardiography.

After percutaneous puncture (15) of the right femoral vein, a specially designed thin-walled radio-opaque polythene catheter of the Ödman-Ledin type (11), 65 cm long and blue in colour (AB Kifa, Solna 3, Sweden) is placed with its tip in the right atrium. This catheter permits not only a higher injection rate but easier passage of the puncture needle than a conventional yellow Ödman catheter.

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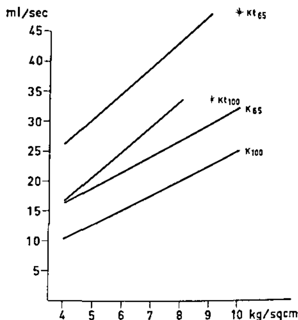


Fig 1 Injection rates through various polythene catheters in relation to the injection pressure (Gidlund's automatic injection syringe) Test injection made with 50 ml Urografin 76 % at 37 C

K_{100} = yellow polythene catheter 100 cm in length of the Ödman Ledin type
K_{65} = same catheter 65 cm in length
Kt_{100} = blue polythene catheter of the Ödman Ledin type thin walled and 100 cm in length
Kt_{65} = the same thin walled catheter 65 cm in length
* = catheter rupture at corresponding injection pressure

The catheter is curved about 4 cm from the tip to an angle of almost 180 degrees and on the inner side of the curve is perforated with three large lateral holes When the catheter is in position the stylet is withdrawn and replaced by the puncture needle (Stille Werner AB Stockholm Sweden) the tip of which is protected by a blunt mandrin inserted into the needle The puncture needle is then carefully advanced under fluoroscopic control until the *catheter and needle tips are at the same level The lateral perforations are so placed on* the inner side of the catheter curve as to prevent the tip of the puncture needle from slipping through them When the needle is advanced through the catheter the curve of the latter is straightened The needle tip is placed at the junction between the lower and middle thirds of the right atrial contour and directed 45 degrees dorsally to the left The needle is then carefully advanced a few centimetres until it meets distinct resistance from the atrial septum The blunt mandrin is then retracted and the atrial septum pierced with the needle tip None of our 31 patients experienced any pain on piercing of the septum though a few of them reported a slight transient sensation of pressure in the thorax and lower part of the neck No electrocardiographic disturbances were recorded The position of the needle tip in the left atrium is checked with the aid of pressure measurement and visual inspection of a few millilitres of aspirated blood The catheter is then advanced over the needle into the left atrium care being taken to insure that all lateral perforations have passed the atrial septum following which the puncture needle is withdrawn The catheter curve prevents its tip from entering a pulmonary vein should such a mishap nevertheless occur it may be rectified by rotating the catheter Prior to the injection of the medium the pressure is once more checked and blood gas analysis is performed The contrast medium employed in these examinations was Urografin 76 % in a dose of 1 ml per kg bodyweight injected at a rate of approximately 35 ml per second (5)

Where selective injection into the left ventricle was desired the catheter was advanced further under fluoroscopic control Before it could be introduced into the left ventricle however it was necessary to reinsert a stylet to facilitate guiding of the catheter The correct position was checked by pressure measurement



Fig 2 Mitral stenosis in a 58-year old man Distinct pressure gradient between atrium and ventricle throughout diastole a) Ventricular systole Filling of large left atrium including the appendage Mitral valves outlined from atrial side The boundaries are irregular and the valves bulge less than normally toward the atrium Large calcified area contiguous to the anterior cusp of the mitral valve (arrow) b) Ventricular diastole The mitral valves form a convexity towards the ventricle Arrows indicate the almost 2 cm wide valvular opening Catheters in left atrium ascending aorta, and pulmonary artery

Material Transseptal angiocardiography was performed in 23 cases 6 of which were cases of mitral stenosis 9 of aortic stenosis 5 of combined mitral and aortic stenosis, and 3 were cases of coarctation of the aorta

Results

Injection into left atrium Contrast medium was injected into the left atrium in 18 cases 6 of which were cases of mitral stenosis 5 of aortic stenosis 5 of combined mitral and aortic stenosis, and 2 were cases of coarctation The entire atrium including the appendage was rapidly and satisfactorily filled Retrograde contrast filling of a pulmonary vein occurred if the catheter tip was in the vicinity of or directed towards any pulmonary vein If however the tip pointed towards the mitral orifice such venous filling was virtually absent

In 10 cases of mitral stenosis isolated or combined with aortic stenosis and a distinct diastolic pressure gradient between the atrium and ventricle, the dome formation typical of mitral stenosis was demonstrable The same was true of the eleventh case which at rest, had no pressure gradient Restricted valvular motility as well as varying degrees of atrial enlargement were observed Five of the abovementioned cases of mitral stenosis were operated upon and the angiocardiographic diagnosis verified (Figs 2 and 3)

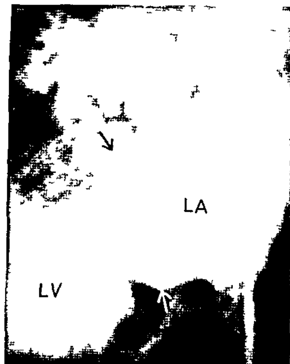


Fig. 3. Mitral stenosis in a 40 year old woman. Abnormal opening of pulmonary veins into right upper pulmonary lobe. Accentuated atrial contraction in left atrium; no diastolic pressure gradient between atrium and ventricle at rest.

Atrial systole. The moderately enlarged atrium is filled. The slightly thickened valves form a dome directed towards the ventricle. *Arrows indicate the mitral ring.* Contrast medium in the ventricle conceals the valvular opening itself, which however is larger than that in fig. 2b.

LA — left atrium
LV — left ventricle

Only in 7 of the ten cases of aortic stenosis in which contrast medium was injected into the left atrium could the dome formation of the aortic valves be observed. In 3 cases simultaneous contrast filling of the enlarged atrium made evaluation impossible. Contrast filling of the left atrial appendage also precluded demonstration of the aortic valves in the right anterior oblique position (Fig. 4).

Satisfactory filling of the stenosed area was obtained in 2 cases with coarctation of the aorta. It was not possible, however, to evaluate the aortic valves, which were probably normal.

Injection into the left ventricle via a catheter inserted through the atrial septum was performed in 5 cases. In the first two of these cases (of aortic stenosis), moderate regurgitation of the medium to the left atrium occurred. This impeded, though it did not altogether preclude, evaluation of the aortic valves. Due to the aforementioned modification, i. e., curving of the catheter to almost 180 degrees about 4 cm proximal to the tip, contrast regurgitation through the mitral orifice was, however, kept to a minimum. The aortic valves were thus demonstrated without overlapping in two cases of aortic stenosis as well as in one of coarctation of the aorta (Fig. 5).

Complications. Transseptal angiocardiography in the cases examined to date has given rise to no appreciable complications. A few ectopic heart beats followed injection of contrast medium into the left atrium in only 3 cases and



a b

Fig 4 Congenital valvular aortic stenosis in a 20 year-old man Ventricular systole a) Frontal view b) Lateral view Arrows mark the dome formed by the slightly thickened valves In both projections the collection of medium in the left atrium and pulmonary veins masks the aortic orifice

into the left ventricle in only one case No intramural injections of medium were observed in this series General anesthesia was not used except in one case of injection into the left atrium and in two cases of injection into the left ventricle All patients received 0 5 to 1 ml morphine scopolamine about 20 minutes prior to angiocardiography None of the patients complained of pain or other discomfort apart from a slight sensation of warmth In one case of aortic stenosis and a major pressure gradient across the aortic orifice as well as previous decompensation pulmonary edema developed about twelve hours after the examination the edema rapidly subsided after adequate treatment In addition to transseptal angiocardiography with injection into the left ventricle right heart catheterization and retrograde catheterization of the ascending aorta hemodynamic tests at rest and during exercise were performed during the same morning in this case

Discussion

Ross et coll (14) have performed transseptal puncture of the left atrium without complications in 130 cases Similarly favorable results have been reported by other authors (6 10) Since transseptal puncture is technically fairly simple and virtually devoid of complications it may well be superior to

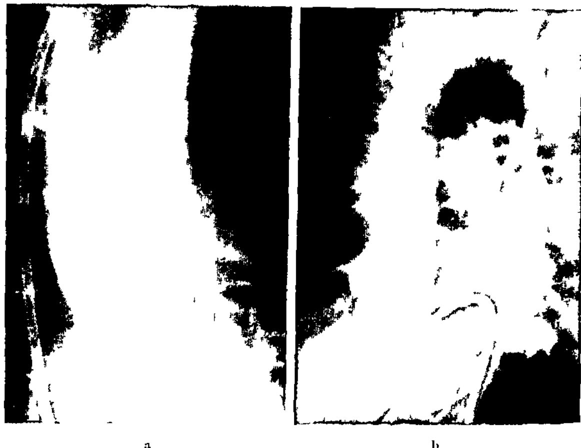


Fig 5 Coarctation of the aorta in a 32 year old man Injection of medium into left ventricle Early ventricular systole a) Frontal view Marked stricture of aortic isthmus Only minimal regurgitation of medium to left atrium throughout the injection b) Lateral view exposed simultaneously with that in (a) Catheters in left ventricle and pulmonary artery

earlier methods such as transbronchial puncture of the left atrium (1, 4), direct percutaneous puncture from behind (2), and direct suprasternal puncture (12)

Angiocardiography has been performed by transseptal insertion of a needle (14), or catheter (16) Judging by the published reports, however, the amount of medium injected per unit time has been too low for satisfactory evaluation of the valvular mechanism The thin walled polythene catheter that we employ permits an injection rate of over 35 ml per second, which corresponds to an injection duration of less than two seconds

If the mitral orifice is to be studied, it seems logical to inject the medium into the left atrium for mitral stenosis and into the left ventricle for mitral insufficiency With injection of contrast medium into the left ventricle by the transseptal method however, regurgitation of the medium to the left atrium occurred in three of our five cases, none of which had any signs of mitral insufficiency The method, therefore, is probably unsuited for determining the presence of mitral insufficiency

In order to obviate overlapping structures the medium should be injected into the left ventricle when studying the aortic orifice In our opinion this method is advantageous even in cases of coarctation of the aorta for the latter condition is not infrequently concomitant with malformation of the aortic valves (7)

Transseptal introduction of a catheter causes remarkably little subjective distress and simultaneous catheterization of the right heart as well as the aorta and left ventricle is readily performed even in conjunction with exercise tests Since selective angiocardiography of the left heart was practicable without general anesthesia and since the catheter caused little discomfort, positioning of the patient in the optimal position on the film changer was facilitated In all angiocardiography with transseptal introduction of the catheter by the technique described appears to be a valuable supplementary method for the examination of the left heart

SUMMARY

Experiences in 23 transseptal angiocardiographies by the selective injection of contrast medium into the left atrium or left ventricle with a specially designed thinwalled polythene catheter is reported The excellent selective filling obtained permits direct demonstration of the valvular apparatus in mitral and aortic stenosis and of luminal changes in coarctation of the aorta The examinations were free of complications and could be carried through without general anesthesia

ZUSAMMENFASSUNG

Erfahrungen aus 23 transseptalen Angiokardiographien mit der selektiven Injektion des Kontrastmittels in den linken Vorhof oder in die linke Kammer mit Hilfe eines speziallkonstruierten dunnwandigen Polythenkatheters werden berichtet Die erhaltene ausgezeichnete selektive Fullung erlaubt die direkte Darstellung des Klappensystemes bei Mitralis und Aortenstenose und von Gefasslumenveranderungen bei der Coarctatio aortae Bei den Untersuchungen traten keine Komplikationen auf Sie konnten ohne Narkose durchgefuhrt werden

RÉSUMÉ

Les auteurs présentent les résultats de 23 angiocardiographies trans septales par injection de moyen de contraste dans l oreillette gauche ou dans le ventricule gauche au moyen d un cathéter du polythène à paroi mince conçu spécial ment pour cet usage L excellent remplissage sélectif ainsi obtenu permet de mettre directement en évidence l appareil valvulaire dans le sténose mitrale et aortique et les modifications de la lumière aortique dans la coarctation aortique Ces examens n ont pas entraîné de complication et ont pu être pratiqués sans anesthésie générale

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MYOCARDIOGRAPHY AND DEMONSTRATION OF THE CARDIAC VEINS IN CORONARY ANGIOGRAPHY

by

BJÖRN NORDENSTRÖM, CARL OLOF OVENFORS and GUNNAR TORNELL

Since the introduction of the method of layering of the contrast material in examinations of the cardiovascular system this technique has been further worked out in our laboratory. Considerable retardation of the blood stream may be provoked in many ways, e.g. by the use of acetylcholine according to ARNULF (1958) or by campho sulfonate trimetaphane (Arfonad) in the method according to PINET (1957/58) and PINET et coll. (1959). The results of an experiment in which a mechanical reduction of the blood flow was obtained by an elevation of the intrabronchial pressure was published by BOEREMA & BLICKMAN (1955). The studies of NORDENSTRÖM (1960) clearly demonstrated that the differences in gravity of contrast medium and blood could easily be utilized both in animal and man for directing the medium to different vessels by sufficient retardation of the blood stream. Such retardation of the blood stream may be used for directing the contrast medium to the coronary arteries. Among the different means of diminishing the blood flow, the effect of acetylcholine, elevation of the intrabronchial pressure and temporary occlusion of the inferior vena cava were tested. These methods may all produce sufficient retardation of the blood stream to induce layering of the contrast material. For several reasons elevation of the intrabronchial pressure was accepted by us as the method of choice.

Our technique of examination of the coronary vessels in man is performed in the following way. An Ödman Ledin catheter is introduced percutaneously through one of the femoral arteries and placed in the ascending aorta immediately above the aortic valves. In the same femoral artery a thin polythene catheter is introduced 2 cm distally to the first catheter for continuous recording

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Fig 1 Coronary angiography by means of the layering method in a dog The reduced blood flow was achieved by means of acetylcholine At the end of the arterial phase a myocardiogram is obtained of the wall of the left ventricle

of the blood pressure After induction of sodium pentothal anesthesia with succinylcholine iodide as a muscle relaxant, a tracheal tube provided with a cuff is inserted into the trachea The patient is then placed in an oblique prone position with the left anterior part of the chest against the film, the coronary arteries being thus directed *downwards in relation to the ascending aorta* After the injection of theophyllin 1 aminopropanol (Oxyphyllin, Astra) to dilate the coronary arteries, the intrabronchial pressure is raised to 40 cm of water by means of a specially developed oxygen injector (NORDENSTROM 1960) and the blood pressure recordings are watched directly on an oscilloscope The arterial blood pressure drops after a few seconds and when it reaches a level of 70 to 80 mm Hg the contrast medium is injected into the ascending aorta, 1 ml Urografin 76 % per kg bodyweight is injected within approximately 3 seconds, and after the end of the injection, the intrabronchial positive pressure is released The arterial blood pressure then starts to rise The whole period of increased intrabronchial pressure generally does not exceed 10 seconds A

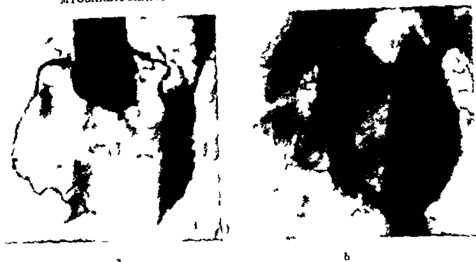


Fig 2 Coronary arteriography in man a) Arterial phase Multiple small stenoses of the right and circumflex artery The anterior interventricular artery is blocked Collateral circulation is visible in the corresponding region b) 7 sec later Myocardiogram of the left ventricular wall

slight tachycardia is consistently observed after this period but no changes occur in the blood pressure or in the ECG tracings During and after the injection stereoscopic films are obtained with the central beam of the tubes directed as perpendicular as possible to the proximal part of the two coronary arteries This procedure was first developed in the dog but has now been performed in about 100 human subjects It was sometimes possible in the dog to demonstrate a phase of contrast accumulation in the heart wall (Fig 1) Most of the examinations in man have been performed in patients seriously ill with angina pectoris In spite of the considerably reduced coronary circulation we have observed a more or less marked accumulation of the contrast material in the myocardium in 15 of these cases This has not been followed by any complication the ECG tracings have been normal

The coronary arteries of a patient with angina pectoris are demonstrated in Fig 2a Considerable atheromatosis may be seen in the left and the right coronary artery The anterior interventricular branch is completely occluded and the lumen of the vessels has irregular walls An area of well developed collateral vessels may be seen in the anterior wall of the left ventricle and this may correspond to the revascularization of an old anterior wall infarction that was previously diagnosed by means of ECG This collateral circulation has developed from small branches originating from the left conus branch and through collaterals from the posterior interventricular coronary artery The first left ventricular branch is tortuous and the circumflex branch in several regions is considerably narrowed When the contrast medium has left the arteries a considerable contrast accumulation in the walls of the left ventricle

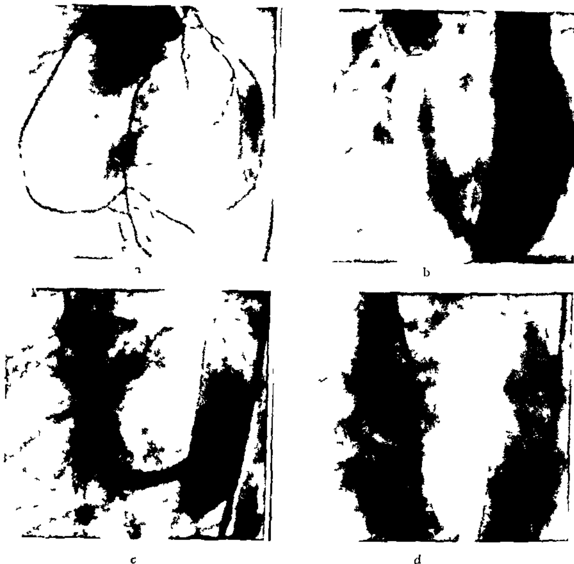


Fig 3 Coronary angiography in man a) Diffuse atheromatosis in the arterial walls b) Demonstration of the wall of the left ventricle and to some degree the right ventricular wall c) Venous phase Parts of the great middle and small cardiac veins and the coronary sinus are seen d) Recirculation phase Contrast medium has passed the superior caval vein and appears in right ventricle The medial aspect of the ventricular septum is outlined

may be seen (Fig 2b) This demonstration of the left ventricular wall persisted for 7 seconds No signs of damage to the myocardium could be observed as judged from the patient s reaction and the ECG tracings

The arterial phases of coronary angiography are depicted in Fig 3a The patient, a man of 45, had suffered from angina pectoris for some years and had previously had an anterior infarction as indicated by ECG He was treated by means of thrombolysine and was admitted for coronary angiography for control of the coronary vessels The arteries on both sides were considerably narrowed with extensive atheromatous changes but without any complete occlusion

During the later stages of the examination a moderate 'myocardiogram' was obtained mainly of the wall of the left ventricle (Fig 3b) This occurred approximately 5 seconds after the start of injection which lasted 3 5 seconds The usual amount of 1 ml Urografin 76 % per kg bodyweight was injected in the ascending aorta immediately above the aortic valves and approximately 7 seconds later the great cardiac vein and posterior interventricular cardiac vein as well as the coronary sinus were filled (Fig 3c) One second later there was also some accumulation of contrast medium in the right ventricular wall Twelve seconds after the injection a recirculation of the contrast medium injected into the aorta appeared in the superior vena cava finally to outline the right atrium and ventricle and the main trunk of the pulmonary artery (Fig 3d)

Discussion

We have chosen up to now to refer to an 'accumulation of contrast medium in the myocardium' although we are not quite sure of the cause of this demonstration of the heart muscle The most probable explanation of this phenomenon is a filling of the myocardial capillaries The first film in which the ventricular wall was seen was the one exposed immediately after release of the positive intrabronchial pressure The film exposed 1/6 sec previous to that still showed good filling of the coronary arteries The absence of complications in our cases with contrast accumulation in the myocardium of the left and right ventricle and the demonstration of the great cardiac veins seems to us to hold some promise for the future with regard to the diagnostic possibilities in cardiac disease Further experiments in animals have been started with this in view

SUMMARY

The authors describe an accumulation of contrast medium in the heart muscle which occurred in coronary angiography with raised intrabronchial pressure in clinical subjects and experimentally in the dog The term 'myocardiography' is suggested for this examination The great cardiac veins are also demonstrated by the method

ZUSAMMENFASSUNG

Die Verfasser beschreiben eine Akkumulierung des Kontrastmittels im Herzmuskel welche bei der Angiographie der Koronargefässe mit erhöhtem intrabronchialen Druck bei Patienten und experimentell bei Hunden auftrat Die Bezeichnung 'Myokardiographie' wird für diese Untersuchung vorgeschlagen Die grossen Herzvenen werden mit dieser Methode ebenfalls dargestellt

RÉSUMÉ

Les auteurs décrivent une accumulation du moyen de contraste dans le muscle cardiaque survenue au cours d une angiographie coronaire avec élévation de la pression intrabronchique chez des malades et expérimentalement sur des chiens Ils proposent le terme de myocardiographie pour cet examen Les grandes veines cardiaques sont aussi mises en évidence par cette méthode

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FROM THE DEPARTMENTS OF EXPERIMENTAL SURGERY (DIRECTOR ÅKE SENNING) AND ROENTGENOLOGY (DIRECTOR BJORN NORDENSTRÖM) THORACIC CLINIC KAROLINSKA SJUKHUSET STOCKHOLM SWEDEN

ANGIOGRAPHIC STUDIES DURING TOTAL LEFT HEART BYPASS WITHOUT THORACOTOMY

by

J R MORENO Å SENNING C O OVENFORS C DENNIS and D P HALL

It was observed during open heart surgery that in cases of massive infarction of the left ventricular wall resuscitation occurred when the left heart had been unburdened for a period by left heart bypass from the left atrium to the aorta. Work in this laboratory has established that left heart bypass can be accomplished by removal of blood from the left atrium without thoracotomy through a cannula passed down the right jugular vein and through the fossa ovalis of the atrial septum the cannula being so positioned that the tip lies in the posterior portion of the left atrium (SENNING et coll.) It was found that the oxygen utilization of the heart can be reduced by nearly half by this procedure (DENNIS et coll.)

Angiocardiography was employed to attempt to determine (1) to what extent the blood in the left atrium is removed through the inlying cannula and (2) whether the blood retrogradely returning to the aorta is in part distributed to the coronary and cephalic vessels. This investigation forms the subject of the present paper.

Methods. A mongrel dog weighing 28 kg was anesthetized with sodium thiopental and a No 10 heart catheter with side holes (NORDENSTROM 1954) was passed by way of the left jugular vein so as to lie with its tip in the main trunk of the pulmonary artery. A metal cannula was then passed down the right jugular vein through the atrial septum and positioned posteriorly. Blood was siphoned from the left atrium through this cannula passed through a

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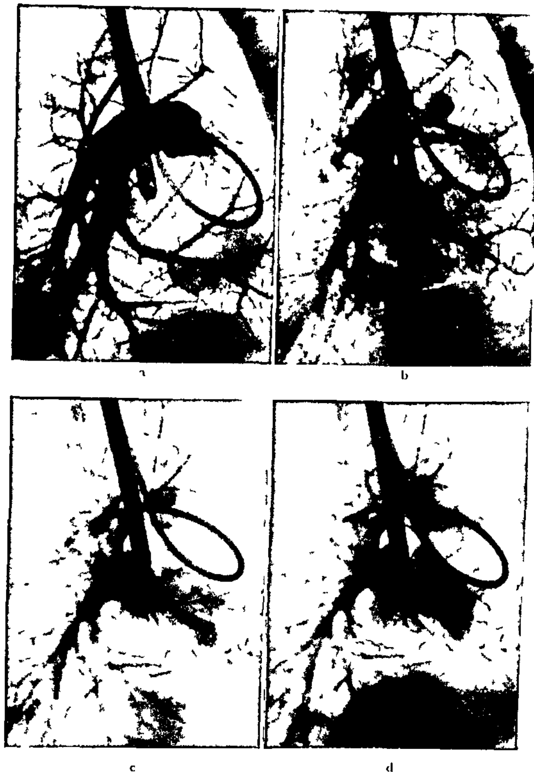


Fig 1 Cannula in left atrium and catheter in main stem of pulmonary artery Intrabronchial pressure 20 cm water 100 ml Urografin injected through the catheter in 2 5 seconds Exposures at 2, 4, 6 and 7 sec after start of injection a) Pulmonary arterial phase b) Pulmonary venous phase c) Ventricular systole d) *Ventricular diastole Most of the contrast medium has disappeared from the left atrium* A small amount has passed to the left ventricle Almost no variation in volume of left ventricle

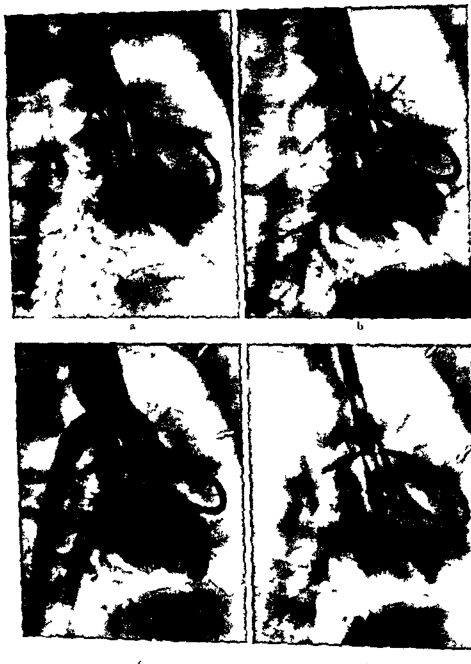


Fig. 2. Same investigation as in fig. 1. Exposures at 17, 18, 25 and 30 sec after start of injection. a) and b) The thoracic aorta is beginning to be filled (arrows). c) Maximum filling. d) The contrast medium is beginning to disappear. Good filling of the carotid, internal mammary and the coronary arteries (arrows).

flowmeter, and a flexible chamber to permit siphonage without contact with air and without volume change of more than 40 ml, to a roller pump, and then through a stainless steel cannula into the proximal part of one femoral artery The flow rate was limited by the amount of blood which could be siphoned from the left atrium with a siphonage level of 90 cm, and the degree to which the pump could be governed to balance this siphon drainage The maximum attainable flow of the circuit, apart from the limitation of blood return to the left atrium from the lungs and Thebesian veins, was 4 2 liters per minute In the experiment now reported, the established flow through the external circuit was 3 2 l/min during the first two series, and 2 3 l/min in the final one

The dog was placed in the left lateral position on a bi plane serial film changer (Elema), so that horizontal rays were used for the frontal projection and vertical rays for the lateral projection In order to improve the quality of the roentgenograms, the lungs were gently inflated to an intrabronchial pressure of either 20 cm or 10 cm of water during the exposure periods The contrast medium was injected with the help of a Gidlund automatic injection device (Elema) through the catheter in the main trunk of the pulmonary artery

In the first study series, two injections, each of 100 ml Urografin 76 % (Schering), were made in 2 5 seconds with an elevation of the intrabronchial pressure to 20 cm of water Films were obtained at a rate of two per second and the period of observation was limited by the equipment to 16 seconds which proved to be insufficient For this reason the rate of one film per second was employed for the other two studies, permitting a duration of observation of 30 seconds

Findings

We observed a good and uniform filling of the pulmonary arteries and veins *while the left atrium was filled only partially A small amount of contrast* medium passed down into the left ventricle where it remained during the whole series of films without entering the aorta The greater part of the contrast *medium must therefore have been removed by way of the cannula* In the film taken 17 seconds after injection, a small amount of contrast medium was evident in the abdominal aorta, and, later on, successive filling of the thoracic *aorta, the brachiocephalic trunk, and the coronary arteries occurred* (Fig 2, c and d)

In another series, only 50 ml Urografin 76 % were injected in 1 3 seconds and *the intrabronchial pressure was raised to only 10 cm of water*, otherwise the experimental conditions were unchanged, except that the initial flow rate was 2 3 l/min and that an assistant continuously adjusted the pump speed to keep the *siphonage bag nearly empty* The final flow rate was 3 0 l/min Following the injection of contrast medium into the main trunk of the pulmonary artery, the distribution in the pulmonary vessels was again uniform

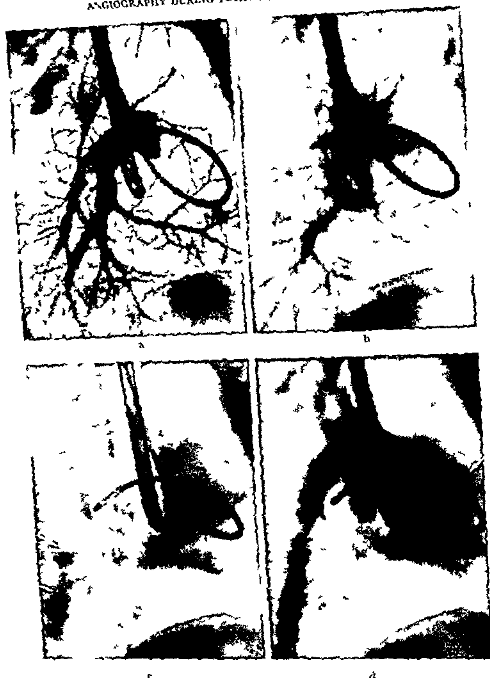


Fig. 3 Same lung as investigated in figs 1 and 2. Injection of 50 ml Urografin in main stem of pulmonary artery during 1.3 seconds. Exposures at 1, 3, 10 and 28 seconds after start of injection. a) and b) Arterial and venous phase respectively. Only a small amount of contrast medium in left atrium. No filling [illegible] ventricle in this [illegible]. [illegible] The thoracic aorta starts to fill from below (arrows). d) Maximum contrast filling of the aorta, carotids and coronaries (arrow).

on the two sides Only the posterior part of the left atrium was filled and, as opposed to the first two series, no contrast medium was apparent in the left ventricle at that time From 20 seconds after the injection successive filling of the aorta, brachiocephalic trunk, internal mammary arteries, and coronary arteries was apparent

As the dog lay on its left side throughout the experiment, some of the contrast medium must have gravitated to the left pulmonary vessels, but no visible difference in contrast density between the right and left sides could be detected in the films In spite of the large doses of contrast medium the general condition of the dog appeared to be unaffected and there was no alteration in the respiration or heart action and no changes in the electrocardiogram

Discussion

The angiographic studies have shown that following the injection of contrast medium into the main trunk of the pulmonary artery all or nearly all the blood may be withdrawn from the left atrium through a transjugular, transseptal cannula In the first two series of films, 100 ml of contrast medium were injected into the pulmonary artery in 2 5 seconds, in these experiments a little medium passed into the left ventricle, but did not reach the aorta The bypass pump was taking 53 ml per second from the left atrium Even if the venous return was influenced during the exposure period by the elevation of the intrabronchial pressure (NORDENSTROM 1960), the pulmonary venous flow rate was rendered momentarily greater by the contrast injection than the rate of withdrawal by the external circuit The volume of contrast medium was therefore reduced in the last experiment to 50 ml in 1 3 seconds and the pump speed was continuously adjusted to keep up with the pulmonary venous return No overflow of contrast medium into the left ventricle was observed

It is clear from the films that blood containing contrast medium reappeared in the abdominal aorta and that it passed in a retrograde fashion so that there was good filling of the cephalic and coronary arteries The left ventricle filled in the first two angiograms and remained filled throughout the remainder of the series, none of the medium passed into the aorta We could not detect any difference between the left ventricular systolic volume and the left ventricular diastolic volume We interpret this to mean that the left ventricle developed no effective contractions during the angiography This conclusion is supported by pressure tracings taken during full left heart bypass, which showed the left ventricular systolic pressure during such periods to be less than half the normal aortic pressure sustained by the return of blood by the external pump (DENNIS et coll)

It is possible to withdraw all or nearly all of the blood coming to the left heart through a cannula placed in the left atrium by way of the jugular vein and atrial septal puncture, and thereby to relieve the external load upon the left ventricle

On its return to the abdominal aorta by way of one femoral artery this blood flows through the aorta in a retrograde direction but under normal mean pressure It flows *in a normal direction* through all the other vessels observed including the coronary and the carotid arteries

SUMMARY

Angiography in the dog demonstrated that it was possible to relieve the load upon the left ventricle by withdrawing all or nearly all the blood coming to the left heart through a cannula introduced without thoracotomy into the left atrium The course of the returning blood flow is described

ZUSAMMENFASSUNG

Durch Angiographie am Hunde konnte gezeigt werden dass der linke Ventrikel durch Absaugen fast der gesamten zum linken Herzen stromenden Blutmenge mittels einer in das linke Atrium eingefuhrten Kanule ohne Thoracotomie entlastet werden konnte Der Verlauf des zuruckstromenden Blutes wird beschrieben

RÉSUMÉ

L angiographie chez le chien montre qu il est possible de soulager le ventricule gauche en aspirant tout ou presque tout le sang arrivant au cœur gauche par une canule introduite sans thoracotomie dans l oreillette gauche Les auteurs décrivent le circuit de retour de ce sang

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ANGIOGRAPHY OF THE INTRAMURAL CORONARY SEGMENTS IN EXPERIMENTS IN ANIMALS

by

ROBERT M LOWMAN and COLIN M BLOOR

Myocardial bridging producing an intramural coronary artery segment has only recently received attention Previous mention of the phenomenon has been made by GEIRINGER (1951), EDWARDS, BURNSIDES, SWARM and LANSING (1956), and by POLACEK (1961) PORSTMANN and IWIG (1960) have indicated that these intramural segments of the artery may be recognized by means of serial coronary angiography However, anatomic confirmation of this radio graphic finding was not presented by these authors Since this muscular for mation which overbridges the arterial course may indeed influence the course and contour of the arterial lumen, the present study is concerned with the macroscopic appearance of the intramural coronary segment in the experi mental animal Attempts to correlate these observations with post mortem findings following coronary arteriography in these animals have been made

Material and Methods

The present observations were recorded during the course of an investigation of the mor phologic sequence of lesions of the coronary vessels of dogs injured by the administration of allylamine Since all factors producing alteration of the appearance of the arterial lumen and the course of the coronary vessels were considered significant in this study the changes associated with the intramural coronary arterial segments were investigated 34 normal un selected mongrel dogs being utilized in the present study Approximately 125 injections were performed in these 34 animals as they were studied by means of the Schonander film changer and *cineroentgenography* *A specially constructed catheter* (LOWMAN and BLOOR 1961) was

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Fig 1 Coronary arteriography perf rmed during ac tylch l ne arrest of a normal can ne h art f lm ol tained 0 7 c aft r inj c t on of Hypaqu 90 Left anterior descending cor nary artery (arrow) filled evenly throughout it course and a sum ng tl u ual ox bow curve No myocard al br dges at post mortem examination

maneuvered into the sup a valvular segment of the aortic arch by means of the carotid or transfemoral approach The contrast medium Hypaque sodium 90 70 and 50 was in jected by means of the Gidlund automatic injector at a pressure of 5 to 6 kg/cm² or by means of the manual injector Fifteen (15) to twenty (20) ml of the contrast medium were utilized in all the injections which were completed either following administration of acetylcholine or during the regular rhythm of the cardiac cycle The Schonander angiographies with the film changer were recorded at the rate of 3 films per second for 5 seconds The cineangiographies were p rformed at the rate of 60 frames per second During the injection lead II of the electrocardiogram was recorded on the Sanborn recording apparatus for the purposes of monitoring the injection Automatic recording of the duration of the injection by means of the Sanborn apparatus was completed in all of the studies

Following completion of the experimental studies on these animals or in unexpected deaths the hearts were removed following sacrifice with nembutal or immediately following death and examined grossly In the cases in which myocardial bridgings were demonstrated their locations were marked and gross photographs were completed

Observations

The post mortem studies of the 34 canines on which angiographies were performed revealed myocardial bridges to be present in the hearts of two of the animals In both in tances the angiographies were completed on these animals utilizing acetylcholine and during the regular rhythm of the cardiac cycle Cineangiocardiography had in these cases been completed prior to al lylamine injections

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ROBERT M. LOWMAN and COLIN M. BLOOR

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Material and Methods

The present observations were recorded during the course of an investigation of the morphologic sequence of lesions of the coronary vessels of dogs injured by the administration of allylamine. Since all factors producing alteration of the appearance of the arterial lumen and the course of the coronary vessels were considered significant in this study, the changes associated with the intramural coronary arterial segments were investigated. 34 normal unselected mongrel dogs being utilized in the present study. Approximately 125 injections were performed in these 34 animals as they were studied by means of the Schonander film changer and cineroentgenography. A specially constructed catheter (LOWMAN and BLOOR 1961) was

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Fig 3 a) and b) Coronary arteri graphy during the regular card ac cycle a) Film ol ta ned at 2 7 sec aft r jection of Hypaqu 90 Refl x into left ven ricle A sharply angular V-curve (arrow) in th l ft a terior descend ng coronary art ry d tal to th origin of th ap cal branch b) Film obta ned at 4 0 s c after inject o of Hypaque 90 A gradually sloped V ben l (rrow) at the same site as i (a) c) Ang ography during acetylchol ne arrest The gradually loped V-cu ve d tortion (a row) per ts d) Gros photograph of the heart A l and of myocard al fibers (arrow) 7 mm in width ross ng o er the left anter or descend ng coronary art ry 1 cm distal f m the o gin of the ap cal branch

course demonstrating the usual ox bow curve Angiography during the regular rhythm of the cardiac cycle (Fig 4 a and b) however demonstrated a small depression on the superior margin of the left anterior descending coronary artery proximal to the site of emergence of the apical branch The shallow depression is approximately 4 mm in length and was seen only transiently The post mortem study of this dog s heart (Fig 4d) revealed a band of myocardial fibers approximately 6 mm in width to cross over the left anterior descending coronary artery proximal to the site of origin of the apical branch Again electrocardiograms before, during and after the angiographies revealed no deviation from the usual normal canine heart pattern



a b

Fig 2 Coronary arteriography during acetylcholine arrest a) A transient defect (arrow) in the left anterior descending coronary artery just proximal to the origin of the intermediate branch appearing on the film obtained 4 3 sec after injection of Hypaque 90 % No myocardial bridge was present at this site at post mortem examination b) A transient defect (arrow) on the film recorded 3 7 sec after injection of Hypaque 90 % located in the left anterior descending coronary artery just proximal to the origin of the apical branch

In one of these two dogs the coronary angiography performed during the regular cardiac cycle (Fig 3, a and b) demonstrated distortion of the usual ox bow curve of the left anterior descending coronary artery 6 mm beyond the site of origin of the apical branch This distortion, best demonstrated in the lateral view, ranged from a gradual sloped V bend to a sharply angulated V curve suggestive of a localized extrinsic pressure on the superior aspect of the artery in successive films The change in the contour of the artery is best demonstrated by means of the cineroentgenographic evaluation When acetyl choline was utilized during angiography (Fig 3c) the distortion of the curve of the left anterior descending artery assumed the gradually sloped V curve With resumption of the usual cardiac rhythm the sharp V shaped angular distortion could again be demonstrated In the post mortem examination of the heart (Fig 3d) a band of myocardial fibers (approximately 1 cm in width) was seen to cross over the left anterior descending coronary artery at a site approximately 8 mm distal from the place of origin of the apical branch The position of the artery as it passes under and then emerges from this myocardial bridge is adequately demonstrated in the roentgenogram The electrocardiogram obtained before, during and after the angiographies demonstrated no deviation from the normal electrocardiogram of the canine heart

Similarly the second animal also had angiographies performed both by utilizing acetylcholine and during the regular rhythm of the cardiac cycle On the angiography following acetylcholine arrest (Fig 4c) there is uniform filling of the left anterior descending coronary artery throughout its entire

and after a varying course under the muscle it will reappear on the epicardial surface once more While the length of such an intermuscular bridge may vary greatly, most often it is 10 to 15 mm In some cases the muscular fibers may lie close on the adventitia of the artery whereas in other cases there is interstitial adipose tissue between the bridge and the adventitia itself POLACEK (1961) has indicated that the thickness of such muscular formations may extend up to 5 mm

Following GEIRINGER's description (1951) myocardial bridging over the coronary arteries has assumed some interest Their relationship to coronary arteriosclerosis has been disputed POLACEK believed that they may play a role in the sclerotic process since he reports the existence of intimal hyperplasia proximal to the myocardial bridging In his cases the intima appeared thin beneath the bridges themselves On the other hand EDWARDS et coll did not observe any difference in the sclerotic process located in the intramural coronary as compared to one present in the extramural epicardial portion of the coronary artery

The frequency of occurrence of these myocardial bridges is also in dispute POLACEK reported their presence in approximately 85 7 % of 70 human hearts examined EDWARDS et coll reported a frequency of 5 4 % in 276 human hearts which were examined In the present small group of 34 dogs the two cases would represent a frequency of 5 9 % POLACEK has stated that these bridges and myocardial loops will occur frequently in experimental animals but has not reported the percentage of occurrence It should be stressed that no myocardial loops arising from the atrial musculature were observed in the present series The possible role of the myocardial bridging in coronary arteriosclerosis and its ability to deform the normal architecture and the peripheral margins of the coronary vessels at angiography warrants reporting of these findings It is important that such features be noted by radiologists and other investigators engaged in coronary arteriography Such distortion may resemble a focal disease process on angiograms It becomes important for the radiologist to recognize that a distortion on a single film should not constitute evidence for the diagnosis of a localized sclerotic deformity in a coronary artery

The distortion produced by myocardial bridging has been alluded to previously by PORSTMANN and IWIG (1960) In addition to the lack of anatomic evidence in the report noted by these authors their illustrations do not show alterations similar to those observed in the present study The transient nature of the distortion produced by myocardial bridging is clearly evident in the angiographies completed during the regular rhythm of the cardiac cycle When acetylcholine arrest is used the distortion of the vessels may be persistent This distortion increases the difficulty of correct interpretation of such a finding The present study makes it evident that the single film technique advocated by some investigators (FABRIKANT et coll 1959) would specifically fail to define this anatomic variant

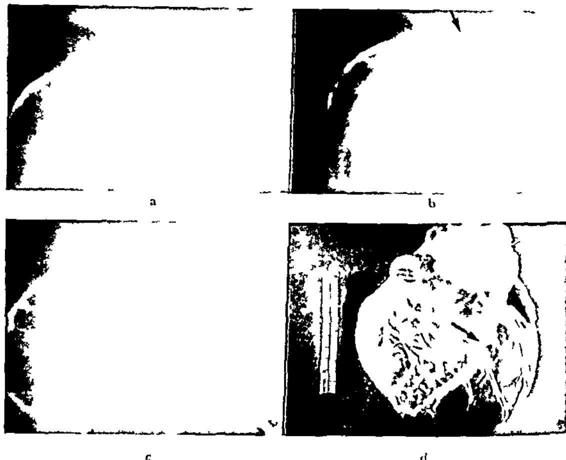


Fig 4 a) and b) Coronary arteriography during the regular cardiac cycle a) Film obtained at 3 3 sec after injection of Hypaque 90% complete filling of the left anterior descending coronary artery b) Film obtained at 4 3 sec after injection of Hypaque 90% a shallow depression (arrow) is transiently demonstrated in the left anterior descending coronary artery at the origin of the apical branch c) Coronary angiography during acetylcholine arrest of the heart Uniform filling of the left anterior descending coronary artery throughout its course d) Cross photograph of the heart A small band of myocardial fibers (arrow) 4 mm in width crossing over the left anterior descending coronary artery just proximal to the origin of the apical branch

In two other dogs (Fig 2, a and b) transient defects were demonstrated in the left anterior descending coronary artery on films recorded during acetyl choline arrest However, post mortem examination of these dogs hearts did not reveal the presence of any myocardial bridges

Discussion

Myocardial bridges occur in the course of the coronary arteries over the ventricular myocardium While they may be seen macroscopically, they can be best demonstrated following the removal of the epicardial adipose tissue The artery may dip under the superficial layer of the ventricular myocardium

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DIAMETER OF THE PYLORIC APERTURE IN RELATION TO THE CONTRACTION OF THE CANALIS EGESTORIUS

by

A D KEET JR

Reading some of the latest text books of anatomy gastro enterology radiology and physiology shows a considerable divergence of views on the nomenclature anatomical structure forms of movement and mechanism of the various divisions of the normal human pylorus It is not proposed to go into all these aspects in a short paper of this nature especially as FORSSELL (1913) and later TORGERSEN (1942) and LILJA (1959) have fully discussed the historical background of our anatomical knowledge of the stomach Suffice it to say that many uncertainties have persisted till the present time and as an example one can mention the loose way in which terms like pyloric sphincter ring valve and canal are used

Taking the term pyloric canal as an example the radiologists SCHINZ et coll (1954) state that it is the central opening in the pyloric ring and is approximately 3 to 5 mm in length TEMPLETON (1947) says that it is 2 to 3 mm in length a view which appears to be shared by the physiologist HOUSSAY (1955) In contrast to the above the anatomists GRAY (1958) and CUNNINGHAM (1951) state that the pyloric canal is 2 to 3 cm in length the physiologists BEST and TAYLOR (1955) 3 cm and the gastro enterologist BOCKUS (1953) 2 54 cm In view of the difference between 3 mm on the one hand and 2 to 3 cm on the other it is clear that anatomists physiologists and radiologists disagree among themselves on the length of the pyloric canal and, by implication, on the true nature of the canal

Submitted for publication 22 August 1961

SUMMARY

Coronary angiographies were performed on 34 dogs Post mortem examination of their hearts revealed the presence of myocardial bridges over the coronary arteries in two At these sites the coronary artery was distorted in a manner resembling a focal disease process

ZUSAMMENFASSUNG

Koronarangiographien wurden bei 34 Hunden durchgefuhrt Die Obduktion ihrer Herzen legte in 2 Fallen die Anwesenheit von Myokardbrucken uber die Koronararterien dar An diesen Stellen zeigte die A coronaris Veranderungen welche den bei fokalen Erkrankungen beobachteten ahnelten

RÉSUMÉ

Le auteurs ont fait des angiographie coronaires sur 34 chiens L examen post mortem des cœurs a montré dans deux cas la pré ence de ponts myocardiques au dessus des artères coronaires Au niveau de ce ponts l artere coronaire presentait une tortuosité ressemblant à un processus pathologique focal

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The investigation has been stimulated by recent pressure readings of ATKINSON EDWARDS HONOUR and ROWLANDS (1957) By passing a chain of balloons into the gastro duodenal junction and connecting each to a manometer it was found that the pylorus behaves no differently from the adjacent parts of the stomach (pyloric antrum) and duodenum (duodenal bulb) It was found that the pylorus in contrast to the cardia is usually relaxed and no manometric evidence of a sphincteric mechanism was found This view was subsequently criticized by JOHNSTONE (1957) who stated that radiologists must have received a severe shock when they realized how much time and energy they had wasted trying to push barium through the pylorus, which according to ATKINSON does not exist as a tonically contracted sphincter If it does not exist it remains to be explained what causes the resistance to the barium when it is manipulated against the pyloric ring

Current views

A huge literature on the opening and closing of the pylorus has accumulated It is not possible to enumerate all the individual authors here and for the sake of brevity various textbooks can be quoted to give an idea of the current teaching and divergence of views

Thus it has been taught for a long time in an anatomical text book (CUNNINGHAM 1951) that the pyloric aperture is firmly closed at rest and during the earlier stages of gastric digestion As digestion proceeds it opens intermittently to allow the passage of chyme According to this view, the sphincter surrounds the aperture (CUNNINGHAM s sphincteric ring) It is usually contracted and relaxes intermittently which can be illustrated diagrammatically as in Figs 1 and 2

Another anatomical text book (GRAY 1958) does not make the question of opening and closing any easier by the statement that the pyloric portion remains in a more or less contracted condition during digestion

The gastro enterologist AVERY JONES (1958) states that there are two schools of thought on the method of regulation of the gastro-duodenal pump

1 The pylorus is the sole regulator so that vigorous peristalsis continues unabated against varying degrees of resistance of the pylorus from this one concludes that the pylorus is usually closed

2 The antrum pylorus and duodenal bulb may be regarded as a single functional unit This view seems to be shared by BOCKUS (1953) quoting the work of *WHEELON and THOMAS (1921 1922)*, THOMAS CRIDER and MORGAN (1934) and CRIDER and THOMAS (1937) that there is a co ordination of motor activity in the antrum pyloric sphincter and duodenum during active gastric emptying When the antrum contracts the pyloric sphincter is relaxed and the duodenum at least partially relaxed

The radiologists SHANKS and KERLEY (1958) state that when a peristaltic wave proceeds towards the pylorus and the pylorus has not opened reflux of

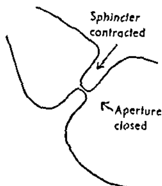


Fig 1 At rest sphincter is contracted and aperture closed (according to CUNNINGHAM)

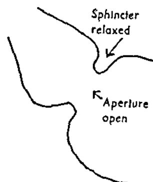


Fig 2 During digestion sphincter relaxes intermittently and aperture opens (CUNNINGHAM)

Similar uncertainties exist about the nature of the pyloric sphincter, which *have been discussed by* FORSSELL *(1913)*, COLE *(1913, 1917, 1928)*, FRIMANN DAHL (1935), TORGERSEN (1942 and 1951), KEET (1952, 1957, 1958), LILJA (1953, 1959) and others

In the present paper it is proposed to deal briefly with the question of opening and closing of the pyloric aperture, where the aperture can be defined as the actual opening of the stomach, which is clearly visible during barium meal investigations, into the base of the duodenal bulb GOLDEN (1951) has stated that radiology is the most important single method at our disposal for studying the living, intact gastro intestinal tract in man BARCLAY (1936) stated that by means of radiology the fluid character of the living anatomy and physiology *can be studied Radiology has been so successful in the diagnosis of patho* logic conditions, that there is a tendency to overlook its applications to physiology and to anatomy In our opinion radiology can play an important role in determining the mechanism of opening and closing of the normal pyloric aperture, a problem about which much uncertainty still exists

The method we have followed is to observe and measure the diameter of the pyloric aperture, i e to determine its size, during various stages of contraction and relaxation of the adjacent prepyloric part of the stomach in several hundred barium meal investigations during a number of years With this method the opening and closing of the aperture in relation to gastric peristalsis can be determined By prepyloric part *is* meant the canalis egestorius as defined by FORSSELL (1913), TORGERSEN (1942) and others It is also the area surrounded by the fan shaped muscle described by COLE (1913, 1917, 1928) and the area of the muscular sphincteric cylinder described by CUNNINGHAM (1906) *It is clear that the canalis egestorius, fan shaped muscle and sphincteric* cylinder are the same structure

pylorus seem to perform the duty of transporting the stomach contents Briefly then according to SCHINZ after the pylorus opens the barium is evacuated into the bulb by the systole of the 'antrum When filling of the duodenum is accomplished at the close of systole the pylorus closes

TEMPLETON (1947) states that the duodenum is separated from the stomach by a clear area about 2 to 3 mm in length when the pylorus is closed As the pylorus opens, a narrow canal, measuring from 5 to 10 mm in diameter is seen to be filled with barium When the canal contracts barium outlines 2 or 3 parallel folds It is not yet established whether the pylorus is open or closed in the resting stage The prompt filling of the duodenum with which all radiologists are familiar suggests that it is open in the resting stage The opening is intimately associated with gastric peristaltic activity and tone There appears to be a passive opening of the sphincter, which occurs when the pressure set up by the oncoming peristaltic wave is in excess of the resistance of the sphincter One deducts from TEMPLETON's description that the sphincter surrounds the aperture

The physiologists BEST and TAYLOR (1955), quoting the balloon pressure readings of WHEELON and THOMAS state that the opinion is now widely held that the pylorus is patent for the greater part of the time and that the evacuation of the stomach is definitely related to the peristaltic activity of the antrum As the constricting peristaltic wave traverses the latter the sphincter becomes relaxed and chyme is expelled into the duodenum The pylorus then closes for a moment relaxing again and remaining open until the next wave of constriction arrives

According to HOUSSAY (1955) a peristaltic wave may either go all the way to the pyloric sphincter or it may provoke a systolic contraction of the antrum Periodically the pylorus opens Quoting CRIDER and THOMAS, it is also stated that the pylorus is open most of the time When the stomach is empty, the pylorus remains open with an occasional rhythmic contraction The evacuation time of the stomach is not significantly modified by the condition of the pylorus

Both SCHINZ and HOUSSAY appear to contradict themselves the latter stating on one occasion that the pylorus opens periodically and on another that it is open most of the time

Pyloric aperture in the rest phase

The rest phase can be defined as the condition in which the stomach and duodenum are empty and thus relatively free from peristalsis The radiologic determination of the state of affairs in the rest phase may not be such a simple matter The mere fact of drinking a barium sulphate suspension produces a non empty stomach Although this suspension is bland and does not undergo the ordinary processes of gastric digestion its volume will soon stimulate per-

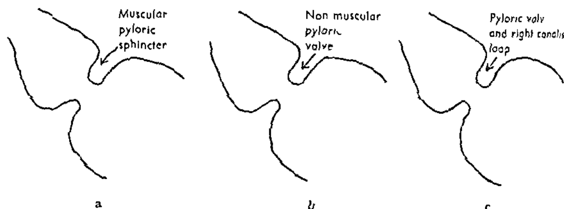


Fig 3 *The contrast free annular defect* a) caused by muscular pyloric sphincter (SHANKS SCHINZ) b) caused by non muscular pyloric valve (COLE) c) caused by non muscular valve and muscular right canalis loop (TORGERSEN)

barium takes place in a cephalad direction, past the peristaltic contraction After a few such abortive waves the pylorus opens, and barium is expelled into *the duodenum* (*From this one concludes that the aperture is usually closed* and that it relaxes only after a variable number of peristaltic waves) It is stated, further, that the pylorus, as seen in profile, is a short, regular canal, approximately 1/4 inch (6 mm) in length *Its calibre depends on the degree* of relaxation of the pyloric sphincter, and varies from nil *up to between* 5 and 6 mm

SCHINZ, BAENSCH, FRIEDL and UEHLINGER (1954) state that the pyloric sphincter can be shown on the roentgenogram as a contrast free annular defect, 3 to 5 mm in breadth Yet COLE, on the basis of his anatomical work, states that this annular defect is not caused by the pyloric sphincter at all, but by the pyloric valve, which is a structure containing only mucosa, submucosa and muscularis mucosae According to COLE it contains no muscularis propria fibres According to TORGERSEN, in a personal communication to the author, the defect is caused by the pyloric valve and the right canalis *loop, the latter* being part of the circular muscularis propria (Fig 3) SCHINZ now states that when the pylorus is open, the pyloric ring (ring and sphincter appear to be synonyms) is usually *pierced in its centre by a* '*barium bridge* between the 'antrum' and duodenal bulb This is called the pyloric canal, which is of varying diameter, depending on the degree of relaxation of the pylorus *Normally* the pyloric ring is never completely obliterated In a stomach of normal tone the pylorus at first remains closed (This is difficult to understand as the same authors state that the pyloric ring is never completely obliterated) Only after a large amount of contrast medium has been ingested, is a periodic opening of the pylorus initiated Quoting GOETZE (1937) SCHINZ also states that gastric evacuation occurs principally through the systolelike contraction of the pars pylorica Only in a secondary way does peristalsis, in the presence of an open

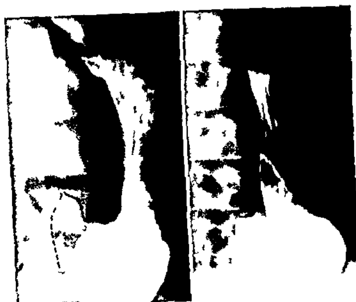


Fig 6 Entire canalis amputated (the part between broken lines) due to spasm This filled later when spasm relaxed

Fig 7 Erect position Hypotonic stomach with delayed peristalsis and emptying (Air bubble in vertical part)

bulb and intervening pyloric aperture In these cases the stomach and duodenum are empty except for the presence of a greater or lesser amount of air which can be looked upon as a physiologic collection of air, and an open pyloric aperture outlined by air is clearly visible (Fig 5)

The above two observations furnish radiologic evidence that in a considerable percentage of normal subjects the pyloric aperture is open in the rest phase

3 A condition which can be called amputation of the canalis egestorius may be present (previous authors have referred to this as amputation of the antrum) In a minority of subjects there may be a spastic condition of the entire canalis egestorius at the beginning of the examination and therefore presumably also in the rest phase which temporarily prevents its filling (Fig 6) The features here which have been described before (KEET 1958) is a spasm of the canalis of FORSSELL and TORGERSEN (or of the fan shaped muscle of COLE or of the sphincteric cylinder of CUNNINGHAM) It should not be confused with a spasm of the sphincteric ring (right canalis loop of TORGERSEN) Depending on the degree of spasm of the canalis, the radiologic appearances may closely simulate hypertrophic pyloric stenosis as described by FRIMANN DAHL (1935) and ASTLEY (1956) In these spastic cases the pyloric aperture is



Fig 4 Barium leaving stomach before onset of peristalsis last few mouthfulls still being swallowed Pylorus open

Fig 5 Open pylorus outlined by air in a fasting (resting) stomach

istaltic activity and at that stage, i e after peristalsis has commenced the stomach can no longer be considered to be at rest However, the following observations will give an idea of the condition of the pyloric aperture in the rest phase

1 When a normal subject is asked to drink a few mouthfulls of barium in quick succession, it often happens that the barium immediately traverses the pyloric aperture to fill the duodenal bulb, even while the third and fourth mouthfulls are still being swallowed In these cases it is common to see the barium leaving through the pyloric aperture while the subject is still swallowing, a phenomenon which is familiar to all radiologists (Fig 4) This happens before the onset of peristalsis and it is clear that in these cases the pyloric aperture is open to begin with, i e in the rest phase The only condition appears to be that the stomach must have a normal tone, or that it must be hypertonic This fact confirms the physiologic experiments of WHEELON and THOMAS (1921), who could not explain the prompt passage of water and neutral eggwhite through the pylorus on the basis of a contracted sphincter It also confirms TORGERSEN s gastroscopic findings that the pylorus is generally open, and the manometric readings of ATKINSON, EDWARDS, HONOUR and ROWLANDS (1957) which showed that the pylorus is usually relaxed

2 We have noted in a number of subjects in whom straight supine abdominal films were taken prior to a barium meal or urography, i e after the usual fasting period of 10 to 12 hours, that air is present in the stomach, duodenal



Fig 8 Diameters of the open aperture (A) and the relaxed canal (B)

Fig 9 Canalis (B) contracting and the aperture (A) has become smaller

Fig 10 Further contraction of canalis (pseudo-diverticulum phase) aperture still smaller

Fig 11 Maximal contraction of canalis aperture closed

firm anatomical basis by their demonstration of the specialized musculature of the canalis egestorius (fan shaped muscle of COLE, and sphincteric cylinder of CUNNINGHAM) MCNAUGHT (1957) subsequently confirmed TORGERSEN's anatomical findings

In previous communications we have described the details of contraction of the canalis as seen radiologically (KEET 1957 1958) In a series of 320 normal subjects the canalis invariably contracted in a characteristic concentric way and we never once saw an annular peristaltic wave going all the way to the pylorus

This is of the greatest importance as much of the uncertainty seems to be based on the belief that ring like peristaltic waves proceed as far as the pylorus Our previous findings showed that in all normal subjects a peristaltic wave acts as a trigger mechanism which initiates a concentric contraction of the entire canalis

We have seen in (1) and (2) under the previous heading that in the majority of normal subjects the pyloric aperture is open in the rest phase Measurements show that the diameter of the adjacent canalis is at its greatest at this stage i e the canalis is relaxed or free from peristalsis Our method now has been to measure the supero inferior width of the pyloric aperture i e its diameter and the diameter of the canalis in a similar way during various degrees of contraction and relaxation of the latter (Fig 8) In order to eliminate technical errors the measurements were done on the original roentgenograms which were taken with the subject in the same position throughout and with the same focus object film distance Care was taken not to exert any external pressure which could flatten the canalis and increase its diameter The examinations were done with conventional spot film devices as we did not have the advantage of cine radiography or rapid cassette changers

Our observations show that during active gastric emptying in all normal subjects the diameter of the aperture A is proportional to the diameter of the canalis B With the largest diameter of B A is also at its widest *In other words*

closed to a greater or lesser extent as part of the general spasticity of the canalis It has to be stressed that in normal subjects amputation of the canalis is a rare occurrence

4 So called pylorospasm may be present In this group of cases barium accumulates in the stomach and does not enter the duodenum for a variable period due to delayed emptying Important points in this condition are the following the stomach is invariably hypotonic, peristalsis is absent, feeble or delayed, and the delayed emptying occurs only *in the erect or semi erect positions* Without any artificial stimulation peristalsis will eventually become more effective and emptying will occur

These cases are usually labelled 'pylorospasm' It is argued that the pyloric aperture is spastic, which causes a decompensation of gastric peristalsis and a *secondary gastric hypotonicity* This view is difficult to accept, as the following points, in our opinion, are against a spasm of the aperture in these cases The sequence of events is different, because, if left alone, peristalsis will become more and more effective and eventually cause spontaneous emptying In decompensation one would expect peristalsis to become more and more feeble, and not to increase spontaneously If a spasm of the aperture were present, it should not be affected by the position of the subject One finds in these cases, that emptying invariably occurs promptly when the right decubitis position is assumed

The following case is an example A female of 15 years showed a hypotonic stomach without any visible peristalsis and emptying for 15 minutes in the erect position (Fig 7) She was put into the right decubitus position and emptying occurred within a matter of seconds, and almost immediately normal rhythmic contractions of the canalis occurred On reassuming the erect position, peristalsis again became very feeble and emptying ceased When the right decubitus position was assumed, prompt emptying occurred again One finds it difficult to accept that a spasm of the aperture will only exist in the erect position, and the explanation, in our opinion, is that there is no real spasm but that the delayed emptying is due primarily to the lack of gastric tone and absent or feeble peristalsis, i e one has to deal with a primary, and not a secondary hypotonicity The effect of the right decubitus position is to distend the prepyloric area, thereby stimulating tone, peristalsis and emptying

Pyloric aperture and contraction of the canalis

In determining the opening and closing of the pyloric aperture, it is of cardinal importance to consider the character of peristalsis in the adjacent prepyloric part of the stomach This contracts in a concentric rather than a peristaltic way, as stated by COLE (1928) GOLDEN (1937) stated that the 'antrum' as a whole contracts, and spoke of 'antral systole and diastole FORSSELL (1913) and TORGERSEN (1942) placed the 'systolic contraction of the antrum' on a

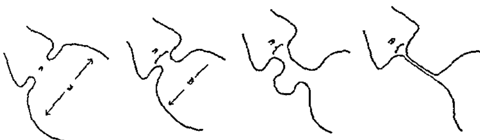


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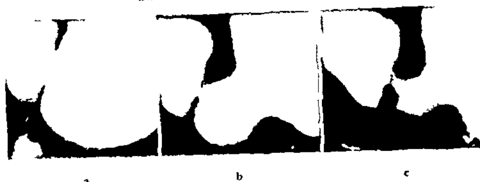


Fig 12 Stages of contraction of canalis a) canalis relaxed pyloric aperture wide b) canalis contracting aperture smaller c) further contraction of canalis aperture still smaller

as well as the diameter of the aperture are now at their smallest i e the aperture is closed (Fig 11)

As evidence of the above roentgenograms obtained during physiologic gastric emptying in two of our normal subjects are presented (Fig 12 and Fig 13) Provided films are taken at the appropriate moments during each cycle of contraction of the canalis this phenomenon can always be demonstrated

A second or two after a maximal contraction the canalis relaxes, and the aperture opens till the next cycle of contraction of the canalis commences In other words the pyloric aperture is only closed during a fleeting stage of each cycle of contraction of the canalis

Actual measurements of the diameters of the canalis and of the aperture in a number of subjects are given in the Table opposite page demonstrating again that the aperture becomes smaller with contraction of the canalis and that it is at its smallest when the canalis is maximally contracted

As far as (3) under the previous heading (amputation of the canalis) is concerned exactly the same phenomenon as described above is seen once the spasm wears off and rhythmic contractions of the canalis commence We have witnessed the following interesting feature in some of these cases at times the canalis is *permanently in a state* of semi contraction The aperture reaches neither its *greatest nor* its smallest diameter but is permanently open to a greater or lesser extent Consequently gastric emptying is rapid due to a so-called patulous aperture This explains the apparent contradiction that gastric emptying is often rapid in cases of partial spasticity of the canalis

Coming now to (4) under the previous heading so-called spasm of the pyloric aperture the normal sequence of events as described for (1) and (2) is seen as soon as the subject is turned into the right decubitus position It is also seen eventually in the erect position, with patience, if the stomach is allowed to empty physiologically

Table

Measurements in 10 normal subjects showing aperture open with canalis relaxed becoming smaller when canalis contracts and at its smallest when canalis is fully contracted

Case	Diameter of canalis		Diameter of aperture
1	Relaxed	4 5 cm	1 3 cm
	Contracting	4 2 cm	0 9 cm
	Fully contracted	1 5 cm	0 8 cm
2	Relaxed	5 4 cm	1 4 cm
	Fully contracted	1 1 cm	0 9 cm
3	Relaxed	5 0 cm	1 2 cm
	Fully contracted	2 0 cm	0 8 cm
4	Relaxed	8 0 cm	1 8 cm
	Contracting	7 0 cm	1 3 cm
	Further contraction	4 3 cm	1 3 cm
	Further contraction	3 6 cm	1 1 cm
5	Relaxed	6 0 cm	1 1 cm
	Contracting	4 5 cm	1 1 cm
	Fully contracted	1 1 cm	0 6 cm
6	Relaxed	5 4 cm	1 7 cm
	Contracting	3 9 cm	1 3 cm
	Further contraction	1 1 cm	0 8 cm
	Fully contracted	0 8 cm	0 6 cm
7	Relaxed	8 2 cm	1 9 cm
	Contracting	3 1 cm	1 2 cm
	Further contraction	1 9 cm	0 7 cm
8	Relaxed	7 0 cm	1 8 cm
	Contracting	2 9 cm	0 7 cm
9	Relaxed	4 5 cm	1 9 cm
	Contracting	3 9 cm	1 5 cm
	Further contraction	1 8 cm	0 7 cm
10	Relaxed	5 6 cm	1 6 cm
	Contracting	4 4 cm	1 4 cm
	Fully contracted	1 7 cm	1 1 cm

the findings show that while the canalis is maximally relaxed, the pyloric aperture is open When a characteristic concentric contraction of the canalis commences, B decreases, and simultaneously A becomes smaller (Fig 9) When the canalis contracts further, through the pseudo diverticular phase both A and B become progressively smaller (Fig 10) Eventually the canalis will be maximally contracted, and the pyloric canal fully formed It will be remembered that FORSSELL taught that the pyloric canal is a physiologic structure which should be differentiated from the pyloric aperture The diameter of the canalis

manently in a state of partial contraction i e neither fully open nor fully closed With total spasticity of the canalis the aperture is closed The state of affairs in this instance is similar to that demonstrated in Fig 11

In a hypotonic stomach, which is otherwise normal the delayed emptying in the erect position does not appear to be due to a spasm of the aperture and secondary gastric hypotonicity, but to a primary hypotonicity of the muscularis propria with absent or feeble peristalsis That the aperture is usually open in these cases as well can be shown by the simple manoeuvre of changing the position of the subject

SUMMARY

The anatomical structure function and nomenclature of the pylorus is discussed The opening and closing of the pyloric aperture was investigated roentgenologically and it was found that the diameter of the aperture is directly proportional to that of the canalis egestorius The aperture is usually patent and closes only for a moment during each cycle of contraction of the canalis The normal annular indentation between the stomach and duodenum should not be confused with the pyloric sphincter Annular peristaltic waves *never reach the aperture* but initiate a concentric contraction of the canalis

ZUSAMMENFASSUNG

Der anatomische Aufbau die Funktion und die Nomenklatur des Pylorus wird diskutiert Das Öffnen und Schliessen der *Pylorusapertur wurde* röntgenologisch studiert und man fand dass der Durchmesser der Öffnung direkt *proportional derjenigen* des Canalis egestorius ist Die Apertur ist gewöhnlich offen und schliesst sich bei jedem Kontraktionszyklus des Canalis nur für *einen Augenblick* Die *normale* ringförmige Einkerbung zwischen Magen und Zwölffingerdarm *sollte nicht* mit dem Pylorussphincter verwechselt werden Die ringförmigen peristaltischen Wellen erreichen die *Pylorusapertur niemals* sondern veranlassen eine konzentrische Kontraktion des Canalis

RÉSUMÉ

L auteur *étudie la structure* anatomique la fonction et la terminologie du pylore L ouverture et la fermeture de l orifice pylorique *ont été étudiés* radiologiquement et l auteur a constaté que le diamètre de cet orifice *est directement* proportionnel à celui du canalis egestorius (antre) L orifice pylorique est habituellement béant et ne se ferme que temporairement pendant chaque cycle de contraction du canalis egestorius L indentation annulaire normale entre l estomac et le duodénum ne devrait pas être confondue avec le sphincter pylorique Les ondes *péristaltiques annulaires* n atteignent jamais l orifice mais marquent le début d une contraction concentrique du canalis egestorius

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Fig. 13. Contraction of canalis. a) canalis relaxed, aperture open. b) canalis fully contracted, aperture closed.

Discussion

From the above radiologic evidence one concludes that the pyloric aperture is open at rest and at the beginning of a barium meal in the great majority of normal subjects. It is also open during the greater part of the meal, closing only for a fleeting stage during each cycle of contraction of the canalis egestorius. When the canalis contracts, the aperture becomes smaller, and it reaches its smallest diameter, i.e. it is closed, when the canalis is maximally contracted.

Although it is widely believed that annular peristaltic waves go all the way to the pylorus, we never once saw this in 320 normal cases. The ring-like peristaltic wave proceeding along the horizontal part of the stomach acts as a trigger mechanism which initiates a concentric contraction of the canalis. This contraction, which is quite characteristic, depends on the microscopic anatomy of the longitudinal and circular muscularis propria, which has been described by various authors and worked out in detail by FORSSELL, COLE and TORGERSEN. Thus the aperture and canalis function as a unit.

The annular indentation between stomach and duodenum seen on roentgenograms should not be equated with the pyloric sphincter. Functionally it *is only a part of the sphincteric mechanism. This mechanism consists of the* entire canalis egestorius. As far back as 1906 CUNNINGHAM demonstrated the sphincteric cylinder, to be differentiated from the sphincteric ring (right canalis loop of FORSSELL and TORGERSEN), but apparently the function of the various parts was not clarified by CUNNINGHAM.

In a small minority of subjects there may be a spasm of the canalis egestorius to greater or lesser extent. With a partial spasticity the aperture may be per-

ROM THE MEDICAL (DIRECTOR DOCENT G WELIN) AND ROENTGEN (DIRECTOR E SELANDER) DEPARTMENT LANSLASARETTET MOLNDAL SWEDEN

XANTHOMA OF THE TENDO ACHILLES

by

GERT BLOMQVIST

The disturbance of the cholesterol metabolism which occurs in cases of hypercholesterolaemia may lead to a more or less significant degree of deposition of cholesterol in various tissues such as the intima of the arteries the endocardium as well as the eyelids and cornea Xanthoma may also be en countered in the skin and tendons and will in the latter situation be of concern to the radiologist

MARCH GILBERT & KAIN (1957) published three cases of xanthomata associated with a raised blood cholesterol level They stated that only one case had previously been described in the American literature and only a few elsewhere

During the last five years we have collected a series of about 150 cases of essential hypercholesterolaemia In many of these cases xanthomata were evident in the tendons and in some cases were the first indication of the hyper cholesterolaemia

The most common sites of xanthomata are in the extensor tendons and they occur most frequently on the dorsal aspect of the fingers and metacarpo phalangeal joints around the olecranon and tibial tuberosity and in the Achilles tendon Those in the latter situation take the form of characteristic fusiform swellings clearly distinguishable from the underlying fatty tissue

Submitted for publication 21 June 1961

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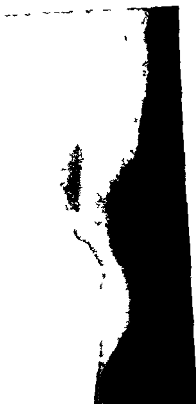


Fig 2 Xant ... relat on to the t bial tubercle

SUMMARY

Xanthoma of the Achilles tendon was demonstrated in 22 cases of a series of 150 cases with a raised blood cholest rol level. The characteristic appearances are described

ZUSAMMENFASSUNG

Xanthome der Achillessehne wurden in 22 von 150 Fallen einer Serie mit erhohtem Blut cholesterolspiegel demonstriert Das charakteristische Bild wird beschrieben

RÉSUMÉ

Xantomes du tendon d Achille sont démontrés en 22 cas d une série ou le niveau de cholesterol du sang est élevé L image caractéristique est decrite

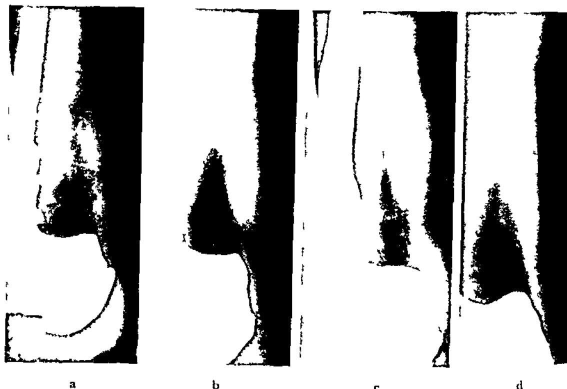


Fig 1 Small (a) medium sized (b) and large (c) xanthoma in tendo Achilles d) Xanthoma with calcifications in tendo Achilles

calcium deposits are sometimes evident Clinically there is tenderness and a thickening of the tendon over which the skin is freely movable Histologic examination reveals xanthoma cells, cholesterol crystals, occasional giant cells and evidence of connective tissue degeneration

Half the tendon xanthomata encountered lay in the Achilles tendon, 7 of the subjects being male and 15 female, a total of 22 cases varying in age from 33 to 71 years The tendons showed the marked fusiform swellings which varied in diameter from 9 to 27 mm and in 5 cases there were distinct calcium deposits The condition was bilateral in all but two cases The size of the swellings bore no direct relationship to the blood cholesterol levels although these as a rule were markedly raised, the average level being about 500 mg% The normal upper limit has been given as 300 mg%

Most of the other tendon xanthomata were small and only a few were examined roentgenologically Fig 2 shows well developed xanthomata in relation to the tibial tubercle

As xanthomata of the tendons are relatively often associated with, and sometimes the first indication of, a raised blood cholesterol level, the recognition of the lesion in the tendo Achilles, which is its commonest site, assumes considerable clinical importance

FROM THE DEPARTMENT OF DIAGNOSTIC RADIOLOGY (DIRECTOR PROF F KNUTSSON),
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TRANSVERSAL TOMOGRAPHY IN THE EXAMINATION OF THORACIC DEFORMITIES (FUNNEL CHEST AND KYPHOSCOLIOSIS)

by

HERMAN LODIN

Assessment of the state of the heart and lungs by means of conventional roentgen techniques is limited in cases of marked deformity of the chest Admittedly it is possible with the aid of a variety of different projections including the usual oblique films combined with tomography and 'barium swallows' to obtain some idea of the morphology of the lungs and pleural cavities the size and shape of the heart and the anatomy of the bones of the chest Important features such as the effect of the sternum upon the shape and position of the heart in funnel chest and the true anatomy of the pleural cavities in kyphoscoliosis cannot however, be assessed The employment of transversal tomography will be found to be of considerable value in mapping out the thoracic organs in these deformities

Funnel chest

The lower part of the sternum including the xiphisternum is depressed, resulting in changes in the position and configuration of the heart The external depth and shape of funnel thus formed may readily be assessed without roentgen examination The outer shape of the chest however is principally a cosmetic consideration and cannot be used to estimate the effect of the deformity upon the thoracic organs The distance between the posterior surface of the sternum and the anterior margin of the vertebrae may be measured in routine roentgen films and with the aid of sagittal tomography it is possible

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more accurately to assess the relation of this interval to the mid line On the other hand in judging the effect of funnel chest on the heart, the information gained by the conventional roentgen examination is limited chiefly to changes in position detailed alterations in shape being difficult to gauge

Transverse tomography can provide information on the following points (1) the establishment of the exact position of the sternum in relation to the vertebral column in cases of asymmetric funnel chest, (2) the demonstration of a change in shape of the heart as a result of the depression of the sternum and (3) assessment of the results of operation

1 The apparent distance between these two bony structures as measured in the lateral film may sometimes be less than the true distance since the depressed sternum may be displaced laterally The true distance may be measured accurately in the transversal tomogram if the exposure is adequate (see Fig 4) If the depressed part of the sternum however consists largely of the xiphoid process this will appear confluent with the heart and the small differences in contrast between the two structures will render accurate assessment difficult or impossible

2 In assessing the configuration of the heart regard must be paid to the errors inherent in the method of tomography and to the morphologic relationships of the structures The large volume and mass of the heart itself result as a rule in a faithful reproduction, but superimposition of detail due to the depressed chest wall may cause distortion The external walls of the funnel contrast sharply with the air within it and at certain phases of rotation stand out in comparison with the rest of the thoracic wall Thus superimposition of details may interfere with the depiction of the underlying heart and produce deformity of outlines (see Fig 4) notably those of the right atrium It is therefore essential that the exposure be adequate to avoid misinterpretation

In order to assess impressions in the anterior wall of the heart due to the depressed sternum the sternum itself must be properly outlined As mentioned earlier the difference in contrast between the xiphisternum and the heart may be too slight in certain cases to allow clear definition of the xiphisternum In such cases reference must be made to adjacent sections and to sagittal tomograms

3 Assessment of the results of operation films obtained after operation as a rule show lesser differences in contrast between the sternum and heart owing to changes in the soft parts following surgery and to the presence of bone transplants A change in configuration of the heart is usually obvious, however

Funnel chest may affect the heart in several ways As EDLING pointed out mild degrees of this deformity are commonly associated with only slight displacement of the heart although with direct compression of that organ In



a



b

Fig 1 Transversal tomograms a) Funnel chest of mild degree The *heart is situated in the middle of the thorax and the anterior wall is* slightly compressed The heart therefore appears oval in the transversal tomogram b) Normal case for comparison

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Fig 2 Transversal tomogram Funnel chest Insignificant displacement of the heart to the left Depressed sternum causing localized compression of the right atrium and probably also the tricuspid orifice The right cardiac border therefore appears markedly angulated (arrow) in the tomogram (cf fig 1)



Fig 3 Transversal tomogram Same case as in fig 2 after operation The position of the sternum and the shape of the heart are now normal usual rounded right cardiac border



Fig 4 Transversal tomogram Extreme funnel chest with marked displacement of heart to the left The depressed sternum (→) lies to the right of the mid line The apparent deformation of the right cardiac border (↔) is partly due to residual superposition of the outline of the left wall of the funnel

extreme forms of funnel chest on the other hand, the heart is in most cases displaced to the left of the sternum and in such circumstances there is little compression of the heart but more or less marked rotation

Undisplaced or insignificantly displaced heart On transversal tomography the heart may appear oval with the longitudinal axis directed from right to left (Fig 1) In more extreme forms of funnel chest there may be either reniform distorsion of the anterior wall of the heart or localized compression of the right side of the heart (chiefly the right ventricle and right atrium) in the latter event the right cardiac border becomes angled instead of rounded (Fig 2)

Roentgen examination of patients after operation reveals a more normal configuration of the heart including an increase in the sagittal diameter at the level of the former depression of the sternum (Fig 3)

Marked left displacement of the heart The displacement is confirmed by transversal tomography Even in extreme cases the configuration of the heart is only slightly changed The depressed part of the sternum is usually easily demonstrated since it lies to the right of the heart and the distance between the



a



b

Fig 5 Transversal tomograms Kyphoscoliosis right convex scoliosis a) Superior part of thorax The hump to the right is due to ribs and a thick fold of lung (arrow) between the latter and the vertebral column b) A cut 4 cm lower demonstrates only a thin fold of lung (arrow) interposed between the ribs and vertebrae



Fig 6 Transversal tomogram Kyphoscoliosis marked left convex scoliosis The *protruding* part of the chest (arrows) consists of ribs immediately under which lie the vertebral bodies without interposing lung tissue

sternum and vertebral column may therefore *readily be assessed* (Fig 4) Transversal tomography *carried out after operation usually* shows slight or no alteration in configuration although the change in position of the *heart* will be *evident*

Kyphoscoliosis

Detailed assessment of the degree and form of the deformity is possible by conventional roentgenographic techniques which also suffice to demonstrate the position and shape of the heart Even with several oblique projections however it may be *difficult to determine the* anatomy of the pleural cavities and any changes in the parenchyma of *the lungs*

The progressive idiopathic *kyphoscolioses are difficult* to treat Apart from the purely medical sequelae of *the deformity of the chest* the patient commonly suffers considerably from the *obvious disfigurement* A correction of the hunchback by thoracoplasty *depends* upon the possibility of obtaining effective collapse of *the underlying lung* The clinical question of whether the disfiguring hump is caused by ribs and underlying lung (Fig 5) or by ribs and/



a



b

Fig 5 Transversal tomograms Kyphoscoliosis right convex scoliosis a) Superior part of thorax The hump to the right is due to rib and a thick fold of lung (arrow) between the latter and the vertebral column b) A cut 4 cm lower demonstrates only a thin fold of lung (arrow) interposed between the ribs and vertebrae

FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (DIRECTOR PROF KNUT LIND BLOM) KAROLINSKA SJUKHUSET, STOCKHOLM, SWEDEN

DEUEL'S HALO SIGN AND ITS COMPARATIVE VALUE IN THE DIAGNOSIS OF FOETAL DEATH

by

LARS OHLSON

The three most reliable roentgen signs of intra uterine foetal death in late pregnancy are gas in the foetal vascular system disalignment of the foetal cranial bones and Deuel s halo sign By these signs it has been possible to determine foetal death in more than 75 per cent of cases examined as shown by BORELL and FERNSTROM (1958)

Gas in the foetal vessels was first described by ROBERTS who published 3 cases in 1944 Since then the number of cases reported has amounted to some 120 The incidence of this sign was first given in 1953 when CRICK and SIMS reported 7 cases out of 30 examined HOLM (1958) demonstrated gas in 19 foetuses in a material which included 40 foetuses in late pregnancy The same year, BORELL and FERNSTROM presented a material comprising 60 cases 39 of which had been examined in the 9th and 10th lunar months foetal intravascular gas was present in 24 of these 39 cases BORELL and FERNSTROM as well as HOLM noted that the incidence increased towards term and that the presence of intravascular gas was the most common and most important sign of foetal death STEWART (1961) reported intravascular gas in 31 cases or 45 % of the material examined only 24 (35 %) of these had however been discovered before birth In one case STEWART encountered gas as early as 12 hours after the probable death of the foetus, in another after 24 hours and in a further 4 cases after 2 days

The halo sign was originally described by DEUEL in 1947 and is caused by a separation of the subcutaneous fat of the foetal scalp from the cranial bones DEUEL described 4 cases but gave no information on the incidence of the phenomenon The halo sign has been referred to by NEUWEILER (1949) ZUP

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or vertebrae without interposed lung tissue (Fig 6) may as a rule be solved with the aid of transversal tomograms The ribs may, however, interfere with the interpretation of the films for, owing to their often horizontal lie, they cause faint superimposed outlines, that is, they may be seen in several sections In such cases it may be difficult to determine whether there is a free space between the ribs and vertebral column, and frontal tomograms then provide a valuable complement Transversal tomography may be useful in assessing the results of thoracoplasty and in the investigation of cases in which there are changes in the pulmonary parenchyma and in which conventional films and tomograms have provided insufficient information

SUMMARY

Transversal tomography is of value in establishing the morphologic relationships between the sternum and the heart and vertebral column and the effect of the sternal deformity on the heart in cases of funnel chest The technique is also useful in mapping out the anatomy of the pleural cavities when assessing the indications for operation in cases of kyphoscoliosis

ZUSAMMENFASSUNG

Die transversale Tomographie ist in Fallen mit Trichterbrust fur die Feststellung der morphologischen Beziehung zwischen dem Sternum dem Herzen und der Wirbelsaule sowie der Einwirkung der sternalen Deformitat auf das Herz wertvoll Die Technik ist auch bei der Darstellung der anatomischen Verhaltnisse der Pleurahohlen bei der Feststellung der Operationsindikationen in Fallen mit Kyphoskoliose wertvoll

RÉSUMÉ

La tomographie axiale transverse e t utile pour établir les rapports morphologiques entre le sternum et le cœur et la colonne vertébrale et pour apprécier l influence de la déformation sternale sur le cœur dans les cas de thorax en entonnoir Cette technique est utile aussi pour étudier l anatomie des cavités pleurales en vue de préciser les indications opératoires dans les cas de cyphoscoliose

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cases and in the 10th month in the remaining 27 cases The mother was suffering from Rh sensitization in 19 cases diabetes mellitus in 5 and toxemia of pregnancy in 3 cases in the remaining 16 cases the mother was healthy

The roentgenologic examination was made 24 to 48 hours after the diagnosis of probable foetal death in 5 cases 3 to 6 days after in 18 cases 7 to 13 days after in 8 cases, 2 to 3 weeks after in 3 cases and one month after the diagnosis in 1 case In a further 8 cases no exact information about the interval between the foetal death and the roentgen examination is available All cases were still births Birth occurred 1 to 6 days after the roentgen examination in 36 cases and 7 to 30 days following it in 7 cases

With our special technique we aim at attaining the best conditions possible for the assessment of intravascular gas halo and disalignment of the cranial bones For the demonstration of foetal intravascular gas lateral views of the maternal abdomen are taken so as to show the foetus as free as possible from the maternal skeleton The maternal soft parts are compressed from the sides by a special clamp described by EDHOLM (1956) If some part of the foetal vascular system can be demonstrated this is considered a positive sign of the presence of intravascular gas For the demonstration of a halo and disalignment the maternal soft parts overlying the foetal head are compressed and an a p view is obtained of the foetal head region of the maternal abdomen with radiation not exceeding 80 kV, a Bucky grid and a small cone This film is usually sufficient for diagnosis but is followed by oblique views if necessary This relatively simple procedure gives a clear reproduction of the subcutaneous fat of the foetal scalp and will demonstrate a halo if present The same films are also suitable for the demonstration of disalignment A control material of 100 live foetuses near term was studied in order to exclude the possibility of mistaking subperitoneal fat for a halo

Results

Halo was found in 36 out of 43 cases (about 84 %) It was present in all 5 cases examined within 2 days after the probable death of the foetus and was the most frequent sign when the foetus had been dead for more than 2 days The incidence was about the same in the 9th as in the 10th lunar months In 6 instances halo was the only sign of foetal death (Tables 1 2 and 3)

Foetal intravascular gas was evident in 28 out of 43 cases (about 65 %) It was present in 3 of the cases examined within 2 days of probable foetal death The incidence varied only slightly after that period and was about the same in the 9th and 10th lunar months Intravascular gas was present, unaccompanied by other signs in 5 cases (See Tables 1 2 and 3)

Disalignment of the foetal cranial bones was encountered in 21 out of 43 cases (about 49 %) It was seen in 2 of the cases examined within 2 days of probable foetal death The incidence decreased from about 60 per cent in the 9th lunar month to about 40 per cent in the 10th month this decrease was due to

PINGER (1952), and STEWART (1957), they published no new cases and considered the sign to be uncommon and unreliable. BORELL and FERNSTROM (1958), however, demonstrated halo in 15 of 39 foetuses in the 9th and 10th lunar months. The incidence of halo was found to increase in proportion to the degree of maturity, in 4 cases it was present as early as 3 days after foetal death. HOLM (1958) reported 9 cases in a series of 40 cases. STEWART (1961) gives no information on the incidence of a halo in a complete series although it appears from his table that in conjunction with gas in the vascular system it occurred in 6 out of 24 cases.

Before the 10th lunar month, disalignment of the foetal cranial bones is diagnostic only in the absence of labour. In the 10th lunar month it should be considered diagnostic only when exceeding 4 mm. The purpose of this limitation *is to exclude the slight degree of disalignment which may be caused* even in the living foetus by false labour pains (BORELL and FERNSTROM 1958). These authors found disalignment of the foetal cranial bones diagnostic of foetal death in 12 cases of 39 cases in the 9th and 10th lunar months. In 3 cases disalignment was present as early as 2 days after foetal death. STEWART (1961) described the sign in conjunction with intravascular gas in 13 cases out of 24 without, however, giving any particulars about its occurrence in a complete series.

Investigations dealing with these three signs that have been published show that disalignment is more commonly encountered than the halo and the intravascular gas before the 9th lunar month but decreases in frequency during the last two months. Gas has been considered a relatively uncommon sign before the 9th lunar month but in late pregnancy seemed to be the most common of the three signs, and it has also been noticed at an earlier stage than the other signs after foetal death. The frequency of halo increases with foetal age, and it is present early after foetal death, yet it has not been reported to occur as often as intravascular gas. It appears, however, that only a small number of examinations have been aimed at demonstrating the subcutaneous fat of the foetal scalp, i. e. of demonstrating the presence or absence of a halo. BORELL and FERNSTROM (1958) described a few cases in which this had been done and these, as might be expected, showed a higher incidence than other materials. These authors, in describing their method, pointed out that there were obvious reasons for using a special technique for the demonstration of a halo. This technique has been in continued practice in our department since 1957, and the experience gained with the new material accumulated up to April 1961 is now presented.

Material and Technique

The material consists of 43 pregnant women, all of which were examined before the onset of labour, and in all of whom there was a vertex presentation. Clinical symptoms of foetal death were evident in the 9th lunar month in 16

downwards, at a distance of 5 to 7 cm from the median line to follow the curvature of the bladder wall It was also thinner and less continuous than the subcutaneous fat layer of the foetus being discernible for stretches of 2 to 4 cm only This layer might have been mistaken for a halo but in all cases could be identified as the subperitoneal fat of the bladder wall

Discussion

Since the technique described was introduced at our hospital we have been able correctly to diagnose all cases examined The signs are particularly reliable for the diagnosis of foetal death in the last two lunar months

Foetal intravascular gas has apparently been considered as the most useful sign of foetal death in the last two lunar months in the investigations previously published The highest incidence reported is about 60 % which compares with 65 % in the present material Halo, however, which has previously been reported in slightly less than 40 % of cases was present in our series in more than 80 % of cases (36 out of 43 cases), and was thus the most frequent sign This may reasonably be attributed to the special technique used for the demonstration of the subcutaneous fat of the foetal scalp which makes it possible to a greater extent than before to ascertain whether a halo is present or not

There was no evidence of a halo in 7 cases of this series The subcutaneous fat lay adjacent to the cranial bones in 4 of these cases thus excluding the presence of a halo In the remaining 3 cases the subcutaneous fat being poorly developed could not be demonstrated and it was only in these 3 cases therefore that it was not possible to determine whether a separation of the fat from the cranial bones had taken place or not The number of cases in which a halo was demonstrated thus closely corresponds to the number of cases in which there was a separation of the fat This implies that the incidences noted earlier are considerably lower than they should have been and that halo is actually much more common than has been supposed The subcutaneous fat of the foetal skull is easily overlooked in ordinary survey films and this is probably the reason for the comparatively low incidences of halo earlier reported

The cases included in this material were not examined roentgenologically until clinically it was suspected that foetal death had persisted for 24 hours or more There were two reasons for this time limit First the probability of foetal death must as a rule be established by repeated clinical observations before a roentgenologic examination is undertaken, this is important from the viewpoint of the radiation hazard Foetal movement and heart sounds may apparently be absent on one occasion to appear again later Secondly the three signs being indications of a process of maceration within the foetus, require a certain time to develop In all probability they subsist when once formed the total incidence thus increasing with the length of time after foetal death After 24 hours at least the halo and intravascular gas are relatively

Table 1

Incidence of halo gas and disalignment in a series of 43 cases

Interval between probable death of foetus and roentgen examination		Number of positive case Halo	Gas	Disalignment
24—48 hour	(5 cases)	5	3	2
3 days	(7 cases)	6	6	3
5 days	(6 cases)	5	4	3
6 days	(5 cases)	3	3	2
1 week	(8 cases)	8	5	6
2 weeks	(3 cases)	2	2	2
1 month	(1 case)	1	0	1
Uncertain	(8 cases)	6	5	2
Totals	(43 cases)	36	28	21

Table 2

Incidence of halo gas and disalignment in the 9th and 10th lunar months

	Halo		Gas		Disalignment	
9th lunar month (16 cases)	+ 13	— 3	+ 11	— 5	+ 10	— 6
10th lunar month (27 cases)	*+ 23*	*— 4*	*+ 17*	*— 10*	+ 11	— 16

Table 3

Occurrence of one sign only

Interval between probable foetal death and roentgen examination	Halo	Gas	Disalignment
24—48 hours	2	—	—
3 days	—	1	—
5 days	1	—	1
6 days	—	2	—
1 week	1	—	—
2 weeks	—	—	—
1 month	—	—	—
Uncertain	2	2	—
Totals	6	5	1

the 4 mm limit of disalignment in the 10th lunar month In one case disalignment was the only sign present (See Tables)

The re examination of 100 control cases of live foetuses showed that the subcutaneous fat of the scalp immediately adjacent to the bone was unmistakable in all cases In 60 cases another layer of fat could be seen to extend along the outside of the uterine wall and in almost all of these it was also seen to turn

and less continuous than a halo Additional evidence may be obtained from an observation of the outline of the bladder and the uterine wall which often appear as clearly defined soft parts

STEWART (1961) has pointed out that the special films taken for the demonstration of a halo involve an additional radiation risk to the mother which might be considered a contraindication to their inclusion This statement could be true only on the assumption that the gas were the most frequent and the most useful sign It is however the halo which is the most frequent and the most useful sign Therefore if the examination is begun by obtaining a small film of the subcutaneous fat of the foetal scalp this will usually suffice to establish a diagnosis and an additional film for the demonstration of foetal intravascular gas will not be required This small film will also enable the demonstration of disalignment if present With this procedure therefore the radiation to the maternal gonads can instead in most cases be considerably reduced

SUMMARY

Forty three cases of foetal death in the 9th and 10th lunar months were correctly diagnosed by means of the Borell Fernstrom technique for the demonstration of the signs of the halo foetal intravascular gas and disalignment of the foetal cranial bones All were observed more often than previously reported A halo was found in 36 cases i e over 80 per cent It thus appeared to be the most frequent sign and exhibited the highest incidence early after foetal death

ZUSAMMENFASSUNG

Dreiundvierzig Falle von Fötustod im 9 bis 10 Mondmonat sind mit Hilfe der Technik von Borell & Fernstrom fur die Darstellung des Halosymptomes des intravaskularen Gases und der Verschiebung des fotalen kranialen Knochengerustes korrekt diagnostiziert worden Alle sind haufiger als bisher beobachtet worden Ein Halo wurde in 36 Fallen (> 80) gefunden Er scheint das haufigste Symptom zu sein und zeigte die hochste Frequenz fruhzeitig nach dem Tod des Fötus

RÉSUMÉ

Quarante trois cas de mort foetale aux 9 et 10 mois lunaires ont été correctement diagnostiqués grâce à une technique spéciale destinée à mettre en évidence le signe de l auréole le gaz intravasculaire foetal et la différence de niveau des os du crâne foetal Tous ces signes ont été observés plus fréquemment qu ils ne l avaient été jusqu alors L auréole a été constatée dans 36 cas c est à dire dans plus de 80 pour cent des cas se montrant ainsi le signe le plus fréquent et souvent aussi le plus précoce

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Table 4

Distribution of halo gas and disalignment in various maternal diagnoses in a series of 43 cases

Diagnosis	Halo	Gas	Disalignment	Total
Rh sensitization	17	15	4	19
Toxemia of pregnancy	0	2	1	3
Diabetes mellitus	5	3	4	5
Mother healthy	14	8	12	16

common, while before then all the signs of foetal death seem to be rare A roentgenologic examination on the first day consequently provides fairly poor chances of obtaining a correct diagnosis If no sign can be demonstrated while clinical evidence persists, this may well lead to a repeat roentgen examination at a later stage when the probability of some sign of foetal death having appeared is greater An excellent illustration of this is provided by STEWART (1961) Of the 31 cases with foetal intravascular gas demonstrated before or after birth, 6 were examined within 24 hours after probable foetal death, only two of these had gas on ante natal roentgen examination On the other hand, the remaining 25 cases, examined more than 24 hours after probable death, presented evidence of intravascular gas in all cases except three

The present series includes a relatively large number of Rh sensitized mothers Rh sensitization appears, however, to bear no relationship to the presence of halo, intravascular gas, or disalignment of the foetal cranial bones (Table 4)

The assessment of a halo is generally not difficult STEWART (1961) has pointed out that it may be hard to distinguish a halo from a caput succedaneum developed during labour The differentiation, however, should not present any particular problems The subcutaneous fat of a caput succedaneum is raised locally and assumes a characteristic dome shape, whereas the margins of a halo form a much smaller angle with the skull and the halo extends more or less 'parallel to the bone for a considerably greater distance (BORELL and FERNSTROM 1957) The differentiation is mainly academic since it is unlikely in the course of a delivery that the question of whether a foetus is dead or not will arise

The differentiation between a halo and the subperitoneal fat of the bladder wall may present a potential source of error If the subcutaneous fat of the foetal scalp is too poorly developed to be discernible, and the subperitoneal fat layer of the bladder follows the uterine wall so as to be projected somewhat peripherally to the foetal skull, the subperitoneal fat may simulate a halo Oblique views will generally indicate the true condition As mentioned previously the fat layer of the bladder wall was unmistakable in films obtained of live foetuses and deviated from the foetal skull at a distance of 5 to 7 cm from the median line to turn downwards along the wall of the lesser pelvis It was also thinner

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MEASUREMENT OF ROTATIONAL DISPLACEMENT IN SUPRACONDYLAR FRACTURES OF THE HUMERUS

by

HENRIK LÖNROTH

A supracondylar fracture of the humerus is the most common fracture of the elbow in children Follow up studies of healed fractures (HOLMBERG 1945 BRO RASMUSSEN et coll 1958 HOFSLI and KOLSTAD 1958) have shown a high incidence of limitations of function and cosmetically unsatisfactory deformities which may lead to arthrosis (WINDFELD 1948) Such deformities have occasionally been observed after extremely slight initial displacement and have therefore presumably been caused by disturbances in growth (HOFSLI and KOLSTAD) The cause is however generally stated to be faulty reduction with lateral and rotational displacement (FRENCH 1959 HOLMBERG HOFSLI & KOLSTAD GARTLAND 1959 MADSEN 1939 WINDFELD) In 13 controlled cases in which a supracondylar fracture had healed with persistent marked rotational displacement HOLMBERG found limitation of movement and/or deformity, usually of the varus kind

Whereas most deformities may be demonstrated by conventional roentgenograms in two projections rotational displacement is considerably more difficult to judge (JENSENIUS 1948) It would appear from the literature that no completely satisfactory technique exists for evaluating the rotation

The following method has been tried by us since 1957 in the roentgenologic examination of supracondylar fractures

The aim is to obtain true lateral projections of the shaft of the humerus and the condylar fragment

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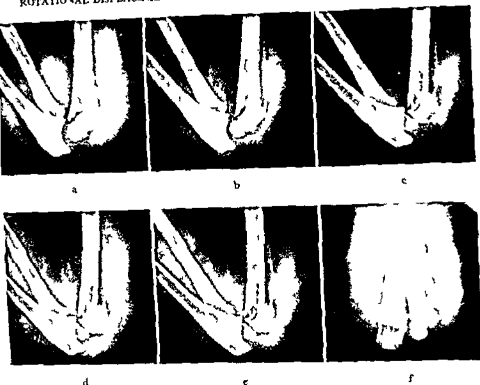


Fig *Supracondylar fracture in healing stage* The order of exposures is as follows a) + 10 b) + 5 c) 0 d) —5 e) —10 f) Frontal view (+ denotes angulation anterior to the humerus — posterior to it) The shaft of the humerus lies tangentially to the central ray in (d) (—5) and the condylar part tangentially in (b) (+5) Thus there is an apparent *inward rotation of* the condylar fragment amounting to 10 in actual fact the true rotational displacement becomes only 5 when a correction for the normal inward rotation of 5 is made

a difference of 10 inward rotation is found the actual deformity will be 5 inward rotation of the condylar fragment if a difference of 5 outward rotation is measured this will represent a deformity of 10° It has not been considered necessary to make an exact analysis of the degree of accuracy of the method The error in measurement would appear to be of the order of ± 5° which for practical purposes is acceptable

Results and Discussion

Measurements with the method described have been made in supracondylar fractures of the humerus in 27 children of from 3 to 12 years of age The distribution of the cases according to the results of measurement is shown in the Diagram p 68 As may be inferred from this diagram the deformity generally consisted of inward rotation as reported by other authors (Bro Rasmussen et coll French Gartland)

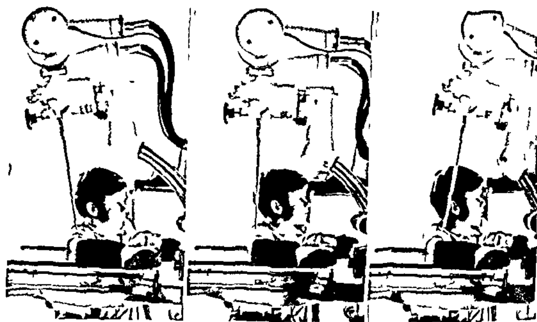


Fig 1 Lateral views of the elbow taken on a Lysholm table The central ray is projected vertically over the condyles of the humerus and adjusted stepwise both anteriorly and posteriorly to the shaft by successively changing the angle

Method

The elbow is placed on the examination table in what is judged to be the lateral position with the central ray directed vertically over the condyles A series of films are then taken at 5° intervals as the tube is moved from a position 15° anterior to the long axis of the shaft to one 15° posterior to it, the centering being carefully maintained (*Figs 1 and 2*) The series is examined and suitable views are selected for the measurements and, since the angles are marked on the films, a calculation of the difference between them will indicate the degree and direction of any rotation

Difficulties may arise regarding what are to be considered true anatomic lateral projections As far as the shaft is concerned, there will generally be no doubt if a film is chosen in which the posterior surface of the humerus is depicted tangentially, and the cortex is seen as a single outline — if the shaft is slightly oblique a double contour will be evident The essential difficulty concerns the condylar *fragment* Its ideal *projection* has been defined *is one in* which the fragment is of minimum width A tangential view of the head or epiphysis of the radius will generally be included and may serve as a guide

In measurements in a series of uninjured elbows at the relevant ages, an inward rotation of about 5° was consistently found when the aforementioned criteria were applied The result must therefore be corrected by this constant difference after the difference in the angles has been calculated If, for example,

antage of fewer exposures, a gain which is questionable, however In the resence of a recent fracture with an elbow that is swollen or in plaster it is ot easy even for an experienced operator to adjust the tube correctly at the rst attempt This will necessarily increase the number of exposures, and it may e just as well to be prepared from the start to make angular measurements y the method described It may be stated here that if an image intensifier is vailable, which at once makes possible an accurate positioning by screening nly a few exposures are required, irrespective of the method

The object of the present paper has been to show the potentialities of the nethod rather than to present results from the orthopaedic or surgical aspects t is evident that the method can provide information for evaluating the possible need for resetting when the degree of rotation is thought to be excessive It may also be used for follow up examinations to assess the final degree of rotation and any limitation of function both as regards the immediate results and the prognosis Consideration may for example then be given to whether, and to what degree remodelling of the rotation and varus deformity is possible Authors who have discussed this question have considered that remodelling is unlikely to occur (ATTENBOROUGH MADSEN)

SUMMARY

An *account is* given of a method for measuring rotational displacement of supracondylar fractures of the humerus and the results in 27 cases are illustrated in a diagram It appears that the method gives good information for the treatment of the fractures and at follow up *examinations*

ZUSAMMENFASSUNG

Es *wird uber* eine Methode der Messung der Rotationsverschiebung bei suprakondylaren Frakturen des Humerus *berichtet und* das Ergebnis an Hand von 27 Fallen illustriert Es scheint dass die Methode gute Information *fur die* Frakturbehandlung und Nachuntersuchung gibt

RÉSUMÉ

L auteur décrit une méthode de mesure de la rotation du fragment inférieur dans les fractures sus-condyliennes de l *humérus* et en montre les résultats dans 27 cas Il en ressort que cette méthode donne de bonnes *précisions pour le* traitement de ces fractures et pour les examens de contrôle

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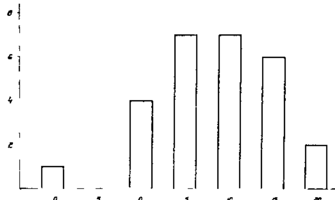


Diagram showing the distribution of cases according to the results of measurement
+ Outward rotation of condylar fragment
— Inward rotation of condylar fragment

The measurements were usually made after reduction and the application of plaster and in most cases the position was checked at subsequent follow up examinations In one case a change of position from 10° outward rotation to 5 inward rotation was observed, and in two cases an increase in inward rotation from 5° to 15° had occurred Examination on the same principle was found practicable, although difficult, in cases in which traction was applied In one such case, 15° outward rotation was measured, after subsequent correction and application of plaster, 5° inward rotation was present No special difficulties were encountered in the examination of oblique fractures running across the bone

It has previously been customary to evaluate rotational displacement only from the anteroposterior and lateral projections GARTLAND, for example, recommended three projections (1) a true anteroposterior view of the arm to include the shoulder and elbow joints, (2) a true lateral view of the elbow joint and (3) a Jones' view (anteroposterior view through the flexed elbow)

By reason of the flattened shape of the distal end of the humerus, it is possible — as pointed out by JENSENIUS — to detect even inappreciable rotation This is because the ends of the fracture are seen to differ in width in both the lateral and the anteroposterior views The degree of rotation is, however, exceedingly difficult to judge The reason is obvious If the degree of rotation is to be assessed with the help of the differences in width, at least one of the fragments must be depicted in an exact anteroposterior or lateral projection The difference in width is then of a maximal value If, on the other hand, the projection is such that the central ray follows the line bisecting the angle of rotation between the fragments, there will be no difference in width, irrespective of the degree of rotation Let us assume that the problem of obtaining a more or less true projection of one of the fragments in either an anterior or frontal view has been solved It should then be possible to calculate the degree of rotation from the differences in width The drawback would be a lesser degree of accuracy, but with the ad

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NEW METHOD FOR COMPLETE URETHROCYSTOGRAPHY IN WOMEN

by

ÅKE GULLMO

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True functional urethrography was introduced by NORDENSTRÖM (1952) to the same purpose After instillation of a sterilized barium suspension through a catheter into the bladder lateral films were obtained with the patient standing and voiding into a specially constructed bag This method is simple and of great value in cases of stress incontinence (INGELMAN SUNDBERG 1952 ERICSSON 1955, FRANKSSON and PETERSÉN 1956 JEFFCOATE 1958) A detailed examination of localized changes within the urethra cannot however be obtained by this method The demonstration of such changes necessitates the injection of a viscous contrast medium which in turn requires an instrument which does not deform or obscure the urethra An attempt was made by KJELLMAN (1952) who devised an instrument based upon the principle of vacuum suction The idea was sound but for practical reasons it was soon discarded, there was often leakage and other inconveniences in the procedure GRANBERG and SVARTHOLM in collaboration with KJELLMAN (1958) however, collected a material of 25 cases of urethral diverticula

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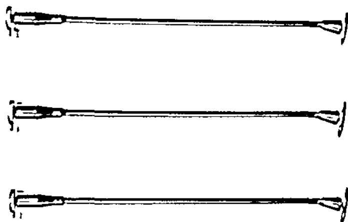


Fig 1 A set of cannulae (usually 5 to 8) with terminal oval plates 8 to 25 mm in diameter

During the last 5 years the author has used a special cannula based on and fitted to the anatomic structures of the urethral meatus It was briefly described in a preliminary report 1958 (in Swedish) and cited in a paper by LINNET JEPSEN (1960) Its simplicity and effectiveness enable complete urethrocystography to be performed even in cases with severe local changes within the urethra (Fig 4)

Technique The instrumentarium consists of a set of 5 to 8 cannulae with a terminal oval plate ranging in diameter from 8 to 25 mm (Fig 1) The plate is set slightly oblique for better adaptation to the meatus The cannula must be 1 5 to 2 mm in diameter in order to permit of the fast injection of a viscous contrast medium

After inspection of the urethral ostium a suitable cannula of the sterilized set is selected and lubricated with Xylocain Gel and then 'buttoned' in behind the ostium In most cases it will fit firmly (Fig 2) and may even be hard to remove after the examination A plastic tube is now connected and water injected in order to test for any leakage Moderate traction on the tube will further tighten the occlusion around the plate and produce better demonstration of the urethra by stretching its distal part

The external ostium of the urethra is surrounded by a ring of fibrous tissue especially in elderly women, which allows good fixation of the cannula to be obtained *Also in young women the external orifice is the narrowest* part of the urethra (DELBET 1923, FURNISS 1935, NEL 1955, HAGLUND 1958) The fossa navicularis (NORDENSTROM 1952) of the urethra embraces the plate of the cannula and holds it in position

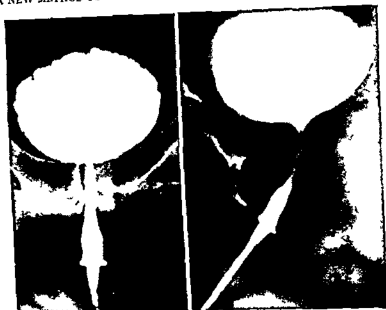


Fig 2 Urethrography with injection in a normal case The cannula is being kept in place by the plate in the external os.

In cases of urethral caruncles or if there is leakage for other reasons the urethral meatus is constricted by one or more agraffes or clamps of the von Wachenfeldt type a procedure which is facilitated by supporting the orifice from the inside with the plate Traction against the artificially narrowed meatus will then prevent any leakage

Women experience no sphincteral resistance on injection and no fluid remains in the urethra after the injection Distension of the urethra must therefore be obtained by means of a viscous contrast medium (Perjodal H Viscous) Films are obtained during injection with the patient supine as well as in the oblique and lateral positions the true frontal view (Fig 3a) which is possible by this method is particularly important Urethral diverticula are always deviated laterally by reason of a fixed medial crista in the posterial wall of the urethra in connection with the septum urethrovaginale (FURNISS 1935) The localization of diverticula is of importance from the surgical standpoint

Because the cannula is applied close to the external meatus the small para urethral ducts of SKENE glands will often be filled Pathologic changes in these structures were never observed Diverticula of clinical importance are as a rule situated in the middle third of the urethra and are associated with moderate narrowing of the lumen in this region

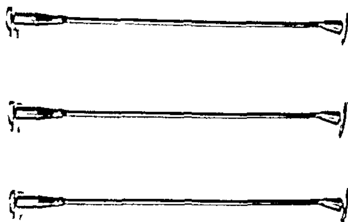


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Fig 3 Diverticulum deviating to the left in the urethrovaginal septum On voiding abnormal descent of the base of the bladder and posterior part of urethra Diverticulum at lowest part of urethra



Fig 4 Strictures following tuberculous urethritis A sound could not be inserted into the bladder A caruncle in the meatus had to be pushed inward and the orifice constricted with an agraffe behind the neck of the cannula

After the urethrograms obtained during injection have been viewed the examination is continued with lateral urethrograms with the patient voiding while standing. Voiding is performed through the cannula and tube which produce a moderate degree of resistance with distention of the urethra. The urine is collected from the tube into a receiver.

Voiding is sometimes delayed by inhibitory reflexes produced by the instrumentation or by psychologic causes. These may be overcome either by premedication with 1 ml carbacholin subcutaneously or by further distention of the bladder with water. The contrast medium will sink to the base of the bladder and therefore not materially affect the density of the contrast medium in the urethra during micturition (Fig 3b).

The cannulae are available from Mr G Crona the Instrument maker Lasarettet Lund or also from Kifa AB Solna 3 Sweden

SUMMARY

A method of urethrography in the female is described for which a special cannula has been developed.

ZUSAMMENFASSUNG

Eine Untersuchungstechnik der weiblichen Urethra, zu der eine Spezialkanyle konstruiert worden ist, wird beschrieben.

RÉSUMÉ

L'auteur décrit une méthode d'uréthrographie chez la femme pour laquelle il a conçu une sonde spéciale.

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FROM ROENTGENDIAGNOSTIC DEPARTMENT I (DIRECTOR PROF S R KJELLBERG),
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FISTULOGRAPHY WITH VACUUM SUCTION

by

ASMUNDUR BREKKAN

A considerable leakage of contrast medium frequently occurs in fistulography due to the instruments available for the procedure not completely occluding the external orifice This leakage often results in unsatisfactory filling of the tract of the fistula Furthermore the examiner must necessarily stand close to the operation field and consequently be exposed to an appreciable radiation dose In an attempt to eliminate these drawbacks the writer has designed a special instrument (Fig 1), the underlying principle of which is the same as that of MALMSTROM s instrument for hysterosalpingography

The device consists of a hard plastic suction cup with slightly bevelled edges which is firmly secured to the skin around the orifice of the fistula by means of suction A cylindric centre piece projects from the bottom of the cup to the skin level The space between the centre piece and the cup wall is evacuated by means of a suction pump and a 500 ml vacuum bottle fitted with a manometer these are connected by a tube to a perforated nipple on the outside of the cup An injection duct runs through the centre piece and the wall of the cup and to this an injection syringe is connected via a second tube

The orifice of the fistula is meticulously cleaned and carefully probed prior to the injection of the contrast medium The suction cup is then applied to the skin so that the central injection duct coincides exactly with the opening of the fistula after which the cup is evacuated until a negative pressure of 0 4 to 0 6 kg/cm^2 has been reached At this pressure the skin is sucked inwards against the inner surface of the cup so that the latter is securely fixed A trial

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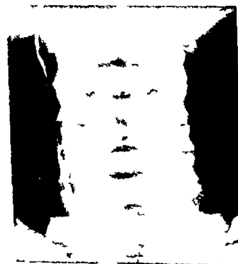
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F g 3 Infected sacral dermoid and anal fistula of 17 years durat n Fistula opening on left glutealf ld w th tract extending outside spl ncters a d opening into an anal crypt



Fig 4 Suppurating fistula in scar after cholecyst ectomy Lateral view Sucti n cup in situ f tula commun cating w th two irregular subdiaphragmic abscess ca it es and with second part of duod num





F g 5 Branchiogenic fistula opening nto ri l t supraclav cular fossa in girl ag d 14

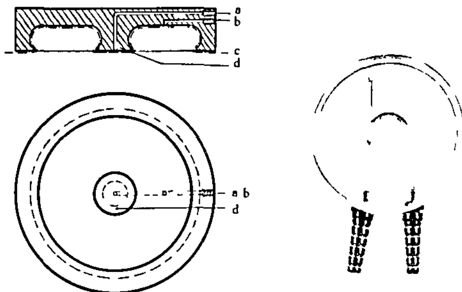


Fig 1 Suction cup in section and from above is shown to the left a — injection canal b — evacuation c — skin d — centre piece

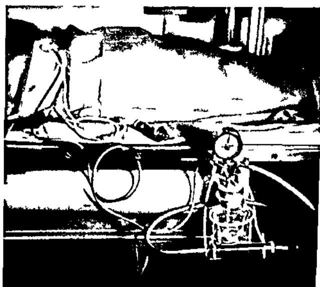


Fig 2 Suction cup and vacuum bottle fitted for injection of fistula in right groin

injection, preferably controlled by fluoroscopy, is then made and, if satisfactory, is followed by the injection proper with the operator standing at about a metre from the patient Roentgenograms are obtained in various projections during the injection, which may be repeated if necessary

Figs 3 to 5 illustrate different types of fistulographies performed by means

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LYMPHANGIOGRAPHY IN LYMPHEDEMA

by

STEN JACOBSSON and SVEN JOHANSSON

The causes of secondary lymphedema are well known although those of primary lymphedema remain obscure. Little knowledge of alterations in the lymphatic system existed until KINMONTH (1954) introduced a technique for the roentgenologic examination of the lymphatics of the extremities.

The lymphatic channels of the extremities are demonstrable in cases of secondary lymphedema. The vessels often follow an irregular course with variation in their calibers and those ordinarily not visible are often outlined. The phenomenon of dermal backflow described by KINMONTH *et al.* 1957, which results from local filling of cutaneous lymphatics, is sometimes evident.

In extremities with primary lymphedema, absence of, or reduction in, the number of lymph vessels or varicosity may be observed. The significance of the roentgenologic appearances remains controversial. The purpose of this paper is to present some new observations and to discuss possible explanations for the roentgen appearances in lymphedema.

Material. Forty-one cases of lymphedema were examined by lymphangiography and venography during the period 1957—1960; 19 of these were cases of secondary lymphedema and 22 were cases of primary lymphedema.

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of this technique The instrument has been used in some sixty cases with satisfactory filling of the tract without leakage

The suction cups are made in plexiglass They are about 10 mm deep and are available in diameters of 30 and 15 mm As they do not well tolerate boiling, sterilization in liquids is recommended (e g Diluform)

Acknowledgement

The technical assistance of Mr Herbert Thorén and of Soderberg AB Gothenburg is gratefully acknowledged

SUMMARY

A vacuum device for facilitating the injection of the contrast medium in fistulography is described

ZUSAMMENFASSUNG

Ein Vakuumvorrichtung zur Erleichterung der Injektion des Kontrastmittels bei der Fistulographie wird beschrieben

RÉSUMÉ

Description d un appareil à aspiration pour faciliter l injection du moyen de contraste en fistulographie

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Fig 2 Secondary lymphedema of the lower extremity Irregular vessels and dermal backflow

flow which is considered a sign of lymphatic stasis was often found locally but not diffusely even when the edema was extensive No reduction in the number of vessels could be demonstrated The same pathologic changes in the lymph vessels were observed in the arm as in the leg

Primary lymphedema The results are summarized in the schematic diagram of Fig 3 No lymph vessels could be demonstrated in 3 cases with bilateral edema and in one case with unilateral edema The other leg in the case with unilateral swelling had normal lymphatics No lymph vessels were found in one leg in



Fig 1 Secondary lymphedema of the upper extremity Irregular vessels besides essentially normal vessels as well as areas of dermal backflow

Secondary lymphedema was always unilateral and in 10 cases localised to the upper limb The appearance of edema was related to the surgical removal of lymph stations in the axilla or groin Primary lymphedema was in all cases situated in a lower limb and in 13 cases both legs were affected There was no case of congenital lymphedema There was a history of a transient swelling during childhood in some cases but the onset generally occurred at puberty, during adolescence, or at pregnancy, 21 of the cases were females

Results

Secondary lymphedema Marked changes in the lymph vessel anatomy were observed in all the examinations The normal lymph vessels were seen together with several small irregular lymphatics and there was evidence of dermal backflow (Figs 1 and 2) Satisfactory filling of all the lymph vessels in the proximal part of the extremity was sometimes difficult to achieve The irregular vessels were usually tortuous, although not dilated Dermal back



Fig 2 Secondary lymphedema ... dermal backflow



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Fig 4 Bilateral primary lymphedema Reduced number of lymph vessel of both extremities

Discussion

Secondary lymphedema The roentgenologic findings in our series were fairly uniform and in accordance with those of COLETTE (1958), KAINDL et coll (1960) and FUCHS et coll (1960) They represent the effect on the lymphatic system of proximal obstruction to the lymph flow There were no clinical or roentgenologic signs of venous obstruction in any of our cases The distribution of the lymphatic vessels is completely different from that in primary lymphedema

Primary lymphedema KINMONTH (1957) published a series consisting of 107 cases of primary lymphedema 87 of which were examined with lymphangiography The material was divided into four groups

1 Aplasia No lymph vessels were found in this group

2 Hypoplasia The roentgenologic examination revealed a definite decrease in the number of lymph vessels compared with the normal

3 Varicose lymph vessels The lymphatics were dilated and tortuous

4 Dermal backflow The dominating finding was the appearance of the contrast medium in small cutaneous lymph vessels in one or several areas

Aplasia and hypoplasia were the most common findings and were seen in about 70 % of the cases

With the exception of this material only small series have been reported (GERGELY 1958 SERVELLE 1960, KAINDL et coll 1960 TSIROS et coll

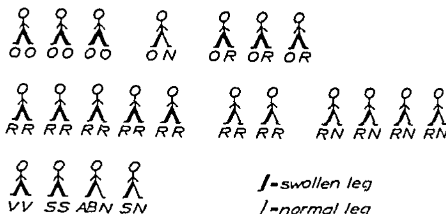


Fig. 3. Schematic representation of the results obtained in 22 cases of primary lymphedema. In unilateral cases it is not indicated on which side the edema occurred. O = no lymph vessels found. R = reduced number of lymph vessels from foot to groin. N = normal. V = varicose lymph vessels. S = lymph vessels too small for catheterization. AB = large lymph vessel abruptly branched into smaller lymph vessels.

three other cases with bilateral swelling, and only one lymph vessel, running from the back of the foot to the groin, was outlined in the other leg. In two of these cases the leg without filling was the first to swell, in the third the two legs became swollen at about the same time.

In 5 cases with bilateral swelling, a reduced number of lymph vessels was found in both legs (Fig. 4). A similar reduction in their number was seen both in the swollen leg and in the non-edematous leg in two patients, aged 12 and 14, with unilateral swelling (Fig. 5). In 4 cases with unilateral swelling a similar reduction in the number of lymph vessels was evident in the swollen leg, with normal lymphatics in the other leg.

In most of our cases with a reduced number of lymphatics, the normal wooly appearance of the outline of the lymph vessels, usually observed 10 to 15 min after injection of the contrast medium, did not appear even after 30 minutes.

Of the remaining 4 cases, one case with bilateral edema presented evidence of varicose lymph vessels, retrograde filling and dermal backflow (Fig. 6), one case with bilateral and one case with unilateral edema had lymphatics that were too small and tortuous for catheterization (the lymphangiogram of the other leg of this last case was normal), and in the remaining case with unilateral edema two large lymph vessels were demonstrated. In the last case the contrast medium was halted abruptly in the upper third of the lower leg and then passed into several small lymphatics (Fig. 7). Dermal backflow was evident above this point but no large lymph vessels were present. The lymphangiogram of the other leg was normal.

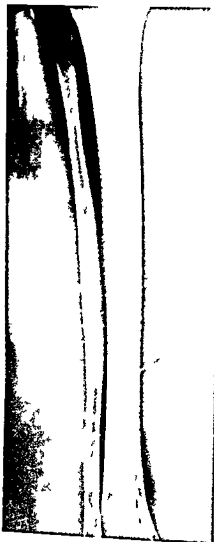


Fig 7 Unilateral primary lymphedema Few lymphatics abruptly branching into smaller lymph vessels and dermal backflow

McKendry et coll (1957) found no lymph vessels in the lymphedematous leg and normal appearances in the other leg in a baby with unilateral lymph edema It may thus be stated that aplasia of the lymphatics exists but the absence of lymphatics in lymphedema does not always imply aplasia

The finding of a reduced number of lymphatics may however signify a congenital malformation hypoplasia even if the lymphedema is not present at birth It is reasonable to assume that the anomalous lymph system can handle the lymph flow in the extremity until with increasing age the extremities outgrow the capacity of the lymph system with resultant edema The occurrence of a reduced number of lymphatics in both the swollen and normal leg in the young patients in our series may be an indication of the process Kaindl recognized two groups of lymphedema with a reduction of the lymphatics, one termed hypoplasia and the other lymphangiopathia obliterans The occurrence and absence in our material of a woolly appearance of the outline of the lymph vessels may indicate a structural difference in the vessel wall In the case without this appearance catheterization of the vessels was often easily performed because of a thickened vessel wall We consider these cases belonging to the group of lymph angiopathia obliterans They may represent either hypoplasia with secondary changes in the vessel wall or a stage in a destruction of a normal lymphatic system It would therefore appear that the finding of a reduced number of lymphatics does not necessarily represent hypoplasia We believe that the lymph vessels are gradually occluded by a pathologic process and that the finding of no lymph vessels is the end result, the reduction in their number may be an intermediate stage in the destructive process The fibrosis



Fig 5 Unilateral primary lymphedema in a 14 year old girl Reduced number of lymph vessels in the contralateral (non edematous) leg Incidental finding benign cyst of tibia



Fig 6 Bilateral primary lymphedema Varicose lymphatics retrograde filling and marked dermal backflow

1960 and WALLACE et coll 1961) KAINDL et coll compared the results of lymphangiography and the microscopic examination of the lymphatics in lymphedema, and on this basis divided the primary lymphangiopathies into five groups (1) hypoplasia and aplasia, (2) lymphangiopathia obliterans, (3) ectasias, (4) Milroy's disease, (5) lymphangitis

Groups 1 and 2 correspond to KINMONTH's *aplasia and hypoplasia* groups The roentgenologic findings in cases of lymphangiopathia obliterans were identical with those in cases of hypoplasia On microscopic examination however, the lymph vessel wall showed an increase in thickness of the intima causing a narrowing of the lumen Group 3 corresponded to KINMONTH's varicose group Groups 4 and 5 had no correspondence in KINMONTH s grouping KAINDL did not mention the number of cases in each group nor the total number of cases in his series

The terms aplasia and hypoplasia, introduced by KINMONTH et coll (1957), implies a congenital malformation There are two possible causes for the absence of lymph vessels congenital aplasia, or destruction of the vessels later in life *In the first instance lymphedema must be present from birth* In none of our seven cases with absence of lymphatics was the lymphedema congenital There are however many cases reported of congenital lymphedema of the limbs but only in a few was lymphangiography performed KINMONTH (1957) reported either no lymph vessels or marked lymphatic changes in such cases

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which occurs in lymphedema may possibly cause this destruction The two cases in our series with a reduced number of lymphatics in one edematous leg and no lymph vessels in the other leg may represent an intermediate stage, and the end result, respectively

Varicose lymphatics represent possibly another entity in lymphedema which may be either congenital or acquired KINMONTH et coll found varicose lymphatics in congenital lymphedema

The roentgenologic appearances in primary and secondary lymphedema differ considerably and no evidence of a common sign was revealed in our two series KINMONTH, however, reported dermal backflow, similar to that seen in secondary lymphedema, on lymphangiography in cases of primary lymphedema, presumably related to congenital malformations of the lymph system in the iliac region

SUMMARY

The roentgenologic appearances of the lymph vessels in primary and secondary lymphedema in a material of 41 cases are described The justification for using the terms aplasia and hypoplasia and the difference in the appearances between primary and secondary lymphedema, are discussed

ZUSAMMENFASSUNG

Das Röntgenbild der Lymphgefässe bei primärem und sekundärem Lymphödem wird in einem Material von 41 Fällen beschrieben Die Berechtigung der Ausdrücke Aplasie und Hypoplasie sowie das verschiedene Aussehen des primären und sekundären Lymphödems werden besprochen

RÉSUMÉ

Sur une série de 41 cas les auteurs décrivent les aspects radiographiques des vaisseaux lymphatiques dans le lymphoedème primitif et secondaire Ils examinent la justification de l usage des termes aplasie et hypoplasie et la différence d aspect entre le lymphoedème primitif et secondaire

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Fig 1 Normal case Oesophagus examination using compression, Maximal width 4 0 cm a) and b) Horizontal position c) Head tilted downwards Supraclavicular segment well expanded and also the intrathoracic diverticulum

Method The patient is instructed to drink 150 to 200 ml of an ordinary barium emulsion and is placed in recumbent position Using the compression apparatus for urographic work one of the rubber balloons is placed over the epigastric region and inflated MARCHAND inflated the compressor to a manometer reading of 60 to 80 mm Hg Since the tolerance of the pressure is very much dependent on the individual and not on a certain manometer reading we modified the method by stopping the inflation when the patient complained of marked epigastric discomfort not however amounting to pain

The table is then raised to an angle of 45 and the patient is given a large spoonful of the same barium emulsion as before and instructed to retain it in the mouth The table is lowered to the horizontal position the fluoroscope adjusted and the patient told to swallow the whole mouthful The first fluoroscopy is important as regards the speed with which the barium passes down the gullet If the speed is too fast for an accurate study of detail the patient is placed in the Trendelenburg position so that the table forms an angle of 20 to 60 with the floor level and given another mouthful of the contrast medium The patient needs a special shoulder support in this position

FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (DIRECTOR PROF. J. FRIMANN DAHL), ULLEVÅL HOSPITAL, OSLO, NORWAY

EXAMINATION OF THE ESOPHAGUS WITH ABDOMINAL COMPRESSION

by

JOHANNES ZIMMER

The ordinary examination of the esophagus does not always give satisfactory or reliable diagnostic results. Some investigators have used a double contrast technique in order to improve the value of the examination. FREIDENFELT, for example, obtained good dilation of the lumen by using a mixture of barium emulsion and carbonic acid gas. The method had the disadvantage that the width of the lumen varied rather rapidly and the examiner had little time to observe the passage of the contrast media. Cineroentgenography (BERRIDGE & GREGG) is reported as being of help in the diagnosis of malignant strictures, the method is rather time consuming. Small sliding hiatal hernias are often difficult to demonstrate. WOLF & GUGLIELMO examined their patients in the prone position and utilized the bodyweight for compression of the abdomen on a small foam rubber pillow. This method does not allow variation of the compression pressure. PECORA inflated a small rubber balloon inside the esophagus for investigation of the gastroesophageal region. This method is rather unpleasant for the patient.

A compression method permitting the use of any pressure desired was reported by MARCHAND in 1952. He stated that his technique was useful for the demonstration of constrictions and sliding hernias.

Realizing the value of examining the esophagus in full expansion a slightly modified Marchand method has been tried. Contraindications have been a poor general condition, or inability to cooperate or swallow. No complications have been observed.

An abstract of this paper was read before the Nordic Congress of Radiology, Åbo, Finland June 1958. *Submitted for publication 14 June 1961.*



Fig 3 Lye burns Lower segment constricted Mucosal pattern of hernial sack well outlined in the erect position (b)
(Verified by esophagoscopy)



Fig 4 a) Widespread involvement of esophageal wall from lye burns (below X) Dilated segment above X in Trendelenburg position (b)
(Verified by esophagoscopy)

compression With adequate compression in the same individual however the lumen could be kept at its maximal width for a much longer period of time Well exercised pressure normally produced a maximal width of 3 5 to 4 0 cm of the intrathoracic segment The supraclavicular segment was sometimes included in these measurements mostly in elderly subjects (Fig 1) If the inflation pressure is kept too high regurgitation of emulsion to the nasopharyngeal region may take place especially if the head is kept too low Measurements exceeding these normal figures indicate increased intraesophageal pressure of long standing as seen in chronic constricting lesions produced for example by lye burns and in achalasia (Figs 4 and 6)

Esophageal stenosis was readily detected with compression The maximal width of the constricted area was brought out, as well as the smooth or jagged outlines and when present ulceration The lower margins of the stenosis were clearly shown (Fig 2) Widespread involvement of the esophageal wall producing less marked constriction may be more difficult to diagnose without the use of abdominal compression Figs 3 and 4 show two different cases of lye burns with a constricted lumen of the lower third of the intrathoracic segment well demonstrated at compression

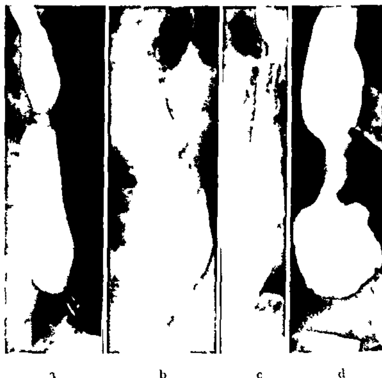


Fig 2 Lye burns a) Two strictures b) Carcinoma c) and d) Esophagitis combined with herniation without (c) and with (d) compression for comparison

The abdominal compression in combination with the tilt of the table usually slows down the speed of the barium considerably and an advantageous retrograde flow is often observed Films are obtained in the true supine or slightly left oblique positions The procedure described is repeated until the examiner is satisfied Semi erect or erect positions may be useful for the examination of the intra abdominal segment of the esophagus

Discussion of observations

Marchand observed a direct relationship between the pressure inside the balloon and the intraperitoneal pressure The intraesophageal pressure will also increase during the inflation and when a mouthful of barium emulsion is swallowed against this raised pressure the esophageal lumen will expand up to its maximum This dilation of the lumen combined with a decreased speed in the flow of the emulsion gives the examiner time to observe and record any lesion of the wall A free flowing emulsion is necessary for maximum dilation, heavier suspensions have a tendency to widen the lumen only temporarily and insufficiently and even to produce contractions of the wall

Fairly good dilation of the lumen of the esophagus for a few seconds have sometimes been seen during ordinary routine examinations without

of the lumen with smooth contours was observed in the case of achalasia A tortuous lumen with a considerable increase in the true width of the esophagus is more likely to be observed in achalasia than in malignant stricture in which the obstruction is more acute

One source of error in the use of compression should be pointed out The higher the intragastric pressure the more often will regurgitation of the contents of the stomach to the esophagus take place (MARCHAND) Hence an observation of reflux during compression cannot be considered of significance unless it also occurs after the abdominal pressure has been released

It is possible that the compression method may improve the diagnostic result in certain extra esophageal lesions such as tumors and enlarged mediastinal lymph nodes but our experience is as yet insufficient to allow definite conclusions in this respect

Conclusions

1 A supplementary method of examination of the esophagus with abdominal compression is described

2 The best results are obtained in intrathoracic lesions such as growths, strictures diverticulas and hernias but the method may also prove of value in lesion of the upper and lower ends of the esophagus

3 The method should be given a trial in extra esophageal lesions such as tumours and enlarged lymph nodes

4 The erect position was found useful in lesions of the lower end of the esophagus

5 Abdominal compression is not required in the examination for evidence of regurgitation.

SUMMARY

A technique of abdominal compression as a supplementary method in the routine examination of the esophagus (MARCHAND) is described Cases which show the value of the method are reported

ZUSAMMENFASSUNG

Eine abdominale Kompressionstechnik als ergänzende Methode bei der routinemässigen Untersuchung des Ösophagus (MARCHAND) wird beschrieben Fälle die den Wert der Methode zeigen werden berichtet

RÉSUMÉ

L auteur décrit une technique de compression abdominale utilisée comme complément de la méthode habituelle d examen de l oesophage (MARCHAND) Il présente des cas montrant l intérêt de cette méthode

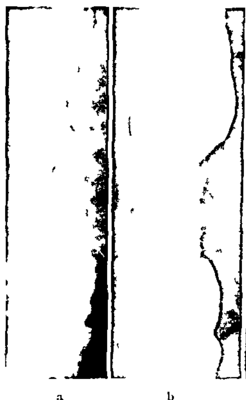


Fig 5 Esophageal carcinoma after extensive roentgen treatment without (a) and with (b) compression for comparison



Fig 6 a) Carcinoma of terminal end of esophagus erect position and compression Lack of peristalsis no dilated lumen below diaphragm b) and c) Achalasia Hyperperistalsis dilation and tortuosity of lumen No rigidity as in (a)

The mucosal pattern of paraesophageal hernia, a type of hernia usually readily diagnosed without compression, was found to be well demonstrated in the erect position with compression (Fig 3b) The presence of an infiltrating process in such a hernia could hardly escape detection

The sliding type of hiatal herniation was well shown with abdominal compression Fig 2c is from a case of esophagitis in which no sign of herniation was observed on routine examination Using compression (Fig 2d) a fairly large hernia was seen just above the hiatal ring, which measured 4 5 cm instead of the normal 2 to 2 5 cm (cf Fig 1)

After roentgen therapy for carcinoma of the esophagus the treated area sometimes appears almost normal on routine examination Compression will disclose the true width of the lumen (Fig 5)

Fig 6 depicts two different lesions, an infiltrating carcinoma and achalasia, respectively, of the intraabdominal part of the esophagus The semi erect and erect positions, with compression, were found to be advantageous in these cases owing to the stretching of the involved area Constant narrowing with absence of peristalsis was present in the case of malignancy, while variation in the width

FROM THE DEPARTMENT OF RADIOLOGY (DIRECTOR W E OVERCASH) THE MEMORIAL HOSPITAL DANVILLE, VIRGINIA U S A

URETERITIS, PYELITIS AND PYELONEPHRITIS EMPHYSEMATOSA

A case report

by

ROBERT MCLELLAND

Gas forming infections of the urinary tract and other anatomic sites have been described on several occasions

Comprehensive reports (1, 2 6) of this and related problems have been presented from the historical clinical bacteriologic pathologic and roentgenologic viewpoints and the reader is referred to the references in the bibliography for this information

The location of the gas has given rise to the following terms

1 Pneumaturia (6 9) — gas mixed with urine within the lumen of the renal collecting system ureter bladder and urethra

2 Cystitis emphysematosa (2 5 10) — gas within the bladder wall

3 Ureteritis emphysematosa (10) — gas within the wall of the ureter (originated as cystitis emphysematosa and extended up ureters)

4 Ureteritis pyelitis and pyelonephritis emphysematosa — as noted in the case presented The precise location of the gas is a matter of speculation but the fact that gas was never demonstrated in the urine, in the lumen of the collecting system or ureter or in peri renal tissues, would indicate that it was in the walls of the collecting system (including the calyces, infundibula and pelvis) and ureter The analogy to cystitis emphysematosa can be drawn in this case except that the calculus obstruction was in the distal ureter, consequently the ascending infection and gas formation were from this point back but otherwise the pathogenesis and sequence of events are presumably the same

Submitted for publication 31 May 1961

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Fig 2 Urography 5 hrs later than in fig 1 revealed mor m k l a c mulati n of gas

In diabetics the gas formation is due to fermentation of carbohydrate In non diabetics (sugar free urine), it has been suggested that the gas forming infections may be due to

1 Fermentation of non reducing carbohydrates

2 Transient appearance of or minimal glycosuria even with hyperglycemia and/or elimination of sugar by fermentation

3 Certain organisms may form gas from proteins or blood clots in urine

4 Urine may be acid at intervals and CO_2 liberated when stagnating acid urine comes in contact with ammonium carbonate in cases of obstruction and infection

The gas forming organism reaches the site of involvement via the blood stream (bacteremia present in this case) or as a result of infected urine (bacteriuria, present in this case) passing through a defect in the epithelial lining of the urinary tract (the ureteral stone had eroded the mucosa in this case)

The transient state of these gas forming infections has been noted previously and apparently explains the unusual and progressive appearance of gas during i v p in this particular case It has been logically proposed that this may account for the infrequent observation of these entities

Case report

Clinical abstract A 53 year old white female who was apparently well until early in the morning of the day of admission when she suddenly developed progressive generalized severe cramping abdominal pain somewhat localized to the left flank and costovertebral angle and accompanied by vomiting Physical examination revealed a temperature of 103 orally pulse 130 and respirations of 24 Blood pressure was first recorded as 160/90 at 2 p m just prior to cystoscopy The rest of the history and physical findings were non-contributory There was no history of the patient or anyone in her family having had diabetes mellitus She was referred to the hospital with a provisional diagnosis of left renal colic probably on the basis of a ureteral calculus

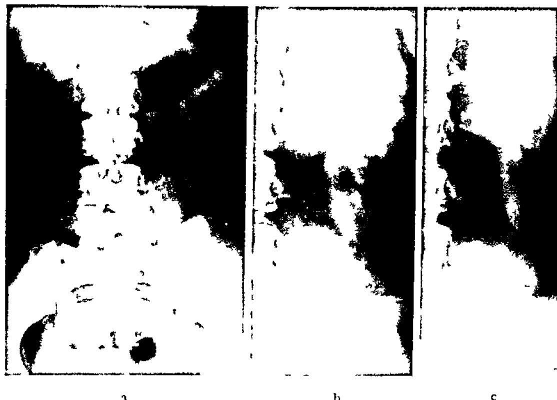


Fig 1 Urography Injection of 30 ml Hypaque a) At 15 min normal excretion on the right and considerable delay in function on the left undoubtedly due to a calculus obstructing the distal portion of the ureter b) and c) At 30 min and 90 min respectively Gradual and progressive accumulation of gas on the left apparently in the walls of the calyces infundibula pelvis and ureter These structures are sharply outlined

5 Renal and peri renal emphysema (3, 7) — gas distributed radially in the renal parenchyma as though within the tissue between the tubules The day following examination gas was also noted extensively about the kidneys and adrenals (comparable to the best peri renal insufflation) No gas could ever be seen within the collecting system, ureter or in the urine

6 Miscellaneous (a) Pneumatosis cystoides intestinalis, (b) cholecystitis emphysematosa, (c) gas forming cellulitis, myositis, abscesses, etc, (d) colpitis emphysematosa, (e) gas gangrene of liver

Apparently there is considerable similarity in the pathogenesis of the various lesions involving the urinary tract, i e frequent obstruction (due to a large opaque calculus in the distal ureter in the case presented), infection usually due to a gasforming colon bacilli (aerobacter aerogenes in this case) although it may be due to other gas forming organisms such as clostridia, and a high incidence of diabetes mellitus (not present or detected in this case) with the bacteriologic medium implications of glycosuria

gestion of the liver spleen and adrenals Bacteriologic studies on the blood and urine revealed a profuse growth of aerobacter aerogenes but gas formation only in the blood sample

LATIMER et coll have presented an interesting and pertinent paper emphasizing the increasing incidence and seriousness of resistant aerobacter aerogenes infections of the urinary tract, apparently due to the ability of this particular organism to quickly change to a highly resistant form This is especially true of chronic infection and they note that there is a high mortality whenever A aerogenes septicemia is present They recommend deferring instrumentation or surgery of the urinary tract, if A aerogenes infection is present until resistance studies indicate that an effective drug or combination of drugs, is available in case of trouble

There was no time to carry out bacterial resistance studies in this case However, it is instructive to note that this patient did not receive any antibiotics or chemotherapy during this illness despite considerable clinical and laboratory evidence of infection undoubtedly due to the primary concern with the painful obstructing stone in the ureter

With the wisdom of retrospect the course of events leading to this woman s death could conceivably have been altered with even *shot gun* antibiotic and/or chemical therapy prior to and during the surgical procedures

SUMMARY

A new form of gas forming infections of the urinary tract is described The gas is located in the walls of the ureter renal pelvis and collecting systems This would suggest the descriptive label implied in the title of the present paper and is consistent with the terminology of similar processes involving other anatomic sites The clinical and roentgenographic features are presented in some d tail and the bacteriologic and pathologic features are briefly discussed

ZUSAMMENFASSUNG

Es wird uber eine neue Form von gasbildenden Urinwegsinfektionen berichtet Das Gas erscheint in den Wand n des Harnleiters Nierenbackens und Sammlungssystems Dies kommt im Titel der vorliegenden Arbeit zum Ausdruck und stimmt mit der Terminologie ähnlicher Prozesse anderer Lokalisation uberein Die klinischen Symptome und die rontgenologischen Befunde werden z T im Detail diskutiert und die bakteriologischen und pathologischen Verhaltnisse kurz besprochen

RÉSUMÉ

L auteur décrit une nouvelle variante d infection des voies urinaires donnant lieu à la formation de gaz Le gaz est situé dans la paroi de l uretère du bassinet rénal et du système collecteur C est ce qu exprime le titre de ce travail L auteur en décrit les caractères cliniques et radiologiques en detail et en examine brièvement les caractères bactériologiques et anatomo-pathologiques

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On admission a urinalysis revealed 1 to 2 WBC/HPF and 1 to 2 RBC/HPF but was otherwise negative with no evidence of glycosuria The WBC was 16 400 with 79 seg 12 bands and 9 lymphs Blood sugar studies were not done ante or post mortem

Roentgenographic findings A conventional film revealed that the left kidney was larger than the right, the left psoas was only faintly outlined There was a moderate left concave scoliosis and possibly an opaque ureteral calculus along with numerous phleboliths in the vicinity of the distal portion of the left ureter

Urography (Figs 1 and 2) revealed considerable delay in function on the left with a progressive nephrogram In addition there was the striking delayed but gradual and progressive accumulation of gas (not present in the conventional 5 min or 15 min films) in the walls of the calyces infundibula, pelvis and ureter on the left with consequent sharp outlining of these structures (Fig 2) There was some minimal accumulation of contrast medium in the collecting system, which was moderately dilated, but the space between the parallel linear streaks of gas in the opposing ureteral walls indicated marked dilatation of the left ureter At no time was gas noted within the lumen of the collecting system or ureter and there was never any evidence of peri renal gas

A diagnosis of left obstructive uropathy due to a calculus in the distal portion of the left ureter with superimposed gas forming infection of the walls of the collecting system and ureter was proposed

Clinical course Cystoscopy was carried out at 2 p m but it was impossible after repeated efforts, to pass a catheter or any other instrument beyond an obstruction in the lower portion of the left ureter The patient s blood pressure was recorded as fairly consistent at 150/90 during the period of cystoscopy which was completed at 3 35 p m The anesthetist remarked that the patient s color pulse respirations and blood pressure were satisfactory, with a smooth and rapid anesthesia and good ventilation throughout the procedure During this period 1 000 ml of 5 % dextrose in water were given intravenously

Operation The BP was 80/60 prior to the administration of anesthesia and dropped to 65/60 shortly after induction The BP rose to 110/80 with the administration of 1 ampoule Vasoxyl 500 ml Dextran 3 ampoules Levophed in 500 ml 5 % G/W and 200 mg of Solu Cortef (IV) A LLQ incision was made and the peritoneum moved medially A markedly dilated and edematous left ureter was easily located and there appeared to be a calculus incarcerated at the uretero-vesical junction The ureter was incised and there was a large outpouring of dark red urine and free gas with a mild fecal odor An attempt was made to extract the calculus with a stone basket from above but this was unsuccessful During this procedure the patient s condition deteriorated markedly and the BP was unresponsive to any of the aforementioned agents The operation was terminated by placing an F 18 rubber catheter in the ureteral opening and drains in the peri ureteral region all of which were brought out through the superior aspect of the wound Rapid digitalization with IV Cedilanid had been attempted because of impending pulmonary edema but the pulmonary edema became marked and unresponsive to suction intermittent pressure oxygen tourniquets and venesection The BP gradually but progressively fell with no response to Levophed and was unobtainable at 10 p m The patient was dead at 10 30 p m It was felt that overwhelming septicemia caused the irreversible shock which resulted in the unresponsive pulmonary edema and death

Autopsy abstract Autopsy revealed a 5 mm incarcerated calculus near the left uretero vesical junction with marked erosion of the mucous membrane at this point and marked diffuse acute ureteritis and pyelitis as well as early acute left pyelonephritis No gas was noted within or about the urinary tract There was massive diffuse acute pulmonary edema with acute con

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BILIGRAFIN FORTE AND SOLU BILOPTIN IN A COMPARATIVE TRIAL

by

ROLF KOHLER and LARS R HOLSTI

Peroral cholegraphy appears to have taken a big step forward since Messrs Schering A G placed Solu Biloptin the calcium salt of β (3 dimethyl amino-methylen amino 2 4 6 tri iodophenyl) propionic acid on the market The literature contains so far only a few reports based on a small series of cases, of the use of this preparation

The aim of the present work was to conduct a comparative study of Biligrafin forte and Solu Biloptin under the most identical conditions possible With this object in view the authors administered the preparations in turn to the same cases after an interval of one day or in exceptional cases several days The majority of the patients received Biligrafin first since the rapid and exact method of administration guaranteed a quicker elimination from the body The authors took a special interest in the serviceableness of the preparations for the diagnosis of biliary duct diseases and in their side effects and paid particular attention to the blood pressure and pulse rate

Material and Methods

Intravenous cholegraphy was performed in 62 unselected cases during a period of 3 1/2 months Thirty cases were given 20 ml Biligrafin forte in 35 to 50 seconds and 32 cases the same dose in 4 to 5 minutes The material was divided in this way because the rate of injection is considered to play a considerable part in producing reactions after intravenous cholegraphy Eighteen of the patients were men, mean age 52 years and 44 were women mean age

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a b

Fig 1 These two films are from one and the same patient a) 3 4 hour after the injection of 20 ml Biligrafin forte and b) 1 1/2 hours after 6 g Solu Biloptin per os Optimal contrast density as usual lower with the oral than with the intravenous technique Residues of Solu Biloptin cover part of the common bile duct

It is obvious that different criteria can be adopted for diagnostically adequate contrast density in the bile ducts This is why the present authors tried to express it more precisely HORNYKIEWYTSCH (1956) stated that the bile ducts were not adequately defined in intravenous cholegraphy i e were not shown adequately for diagnosis in 12 % of the cases Good definition of the bile ducts was obtained by GUNNARSON (1959) in 70 % of his 116 cases with Biliodon natrium capsules The definition was faint in 19 % This author considered that the results were comparable to those obtained with intravenous injection of Biligrafin forte and based this assertion on 58 cases studied with both the oral and the intravenous method BOGATZKI (1959) achieved adequate filling of the bile ducts with SH 550 = Solu Biloptin in about two thirds of cases in a probably fairly small series on which he gave no detailed information It was said by SALTZMAN (1960) that it is possible to demonstrate the bile ducts just as effectively by means of Solu Biloptin as by intravenously injected Biligrafin forte or orally administered Biliodon natrium

18 years Half the cases had not been operated on, the rest had undergone c
cystectomy With the exception of one case of severe shock after the i
venous examination, the remaining 61 cases were also given 6 g Solu Bil
suspended in 2 dl tapwater This medium was usually administered the
after the intravenous examination once it was seen from a few cases tha
results were similar in the reversed order The patients were kept in a
recumbent position, right side down throughout all the examinations
were taken at 15 min intervals during the first hour and then at 30 min
vals until the optimal contrast density for the bile ducts had been passed
meant that the intravenous examination could be terminated after 2 l
whereas the oral studies sometimes continued up to 4 hours

The diagnostic significance of the studies as regards the bile ducts was r
Attention was also paid to the time between the administration of the co
medium and its first appearance and the optimal concentration in th
ducts Accumulations of the contrast medium in the stomach or the duod
which masked the bile ducts were also noted Side effects in the form of n
vomiting, urticaria, abdominal pain and headache were carefully record
note was made of the taste reaction to Solu Biloptin, 18 patients consi
that it was nice, 14 were indifferent to it and 29 found it unpleasant

Systolic and diastolic blood pressure measurements in the conventional
ner were carried out with a cuff around the patient's arm before the begi
of the investigation and after the patient had been lying for some minu
the examination table The pulse rate was measured at the same time
same measurements were made in the intravenous cholegraphies 1, 3,
15, 20, 30 and 40 minutes after the termination of the injection The or
aminations were followed for up to 60 minutes after the administration
contrast medium Ten of the 62 patients had hypertension initially The
pressure values of the others were considered to be within the normal ra

Results

Diagnosis The diagnostic result of the examination of the bile ducts wa
sified as excellent, good, poor or nil In the first two categories were inc
the cases in which the contrast density was sufficient for the establishm
details such as e g the presence of concrements Filling was considered
if the width of the bile ducts and the course of the passage were all that
be detected in the films The percentual distribution in the groups mentio
shown below

Preparation	Contrast density in bile duc		
	Excellent %	Good %	Poor %
Biligrafin	53	29	14
Solu Biloptin	7	33	52

Table 1

Reactions in patients given injections of Biligrafin as compared with injections of Solu Biloptin

	Biligrafin	Solu Biloptin
Number of cases	62	61
No reaction	35	50
Nausea	13	5
Vomiting	7	3
Urticaria	2	nil
Headache	1	1
Abdominal pain	2	2
Sneezing	1	nil

(1959) found in his large series Solu Biloptin gave considerably fewer reactions and was thus definitely superior to Biligrafin in this respect WHITESIDE (1961) noted the same positive property in Solu Biloptin

Blood pressure and pulse rate As the authors had no access to special apparatus to measure blood pressure this was done in the conventional manner The blood pressure was recorded intra arterially for at least 20 min by SALTZMAN & SUNDSTROM (1960) but the curves in their paper ended after a good 15 min and about 7 min respectively The present authors began the recording in the intravenous studies 1 min after the end of the injection and continued up to 40 minutes The Solu Biloptin patients had their blood pressure taken for the first time after 3 min because their mode of reaction was slower but they were then followed up to 60 minutes

The present authors apparently failed to record the rapid fluctuations in blood pressure difficult to demonstrate with the cuff method which SALTZMAN & SUNDSTROM reported Of advantage on the other hand were the observations during the protracted course of the investigation These blood pressure changes which were observable during a long period of time could be of at least the same importance as the period of depression which sets in quickly but passes off rapidly

Intravenous cholegraphies An initial and generally steep elevation of systolic blood pressure was observed in half the Biligrafin cases It was over 10 % in 6 rapidly and 5 slowly injected cases The blood pressure then usually fell either slowly in the course of about an hour to the initial value or more quickly and steeply to in every other case below the starting value The diastolic pressure usually behaved similarly and the pulse rate changes were on the whole congruent (Fig 4) Nine of the 11 patients with a marked reaction experienced nausea or vomited the other 2 patients felt perfectly well

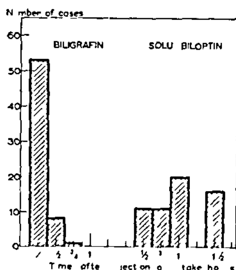


Fig 2 Time between the administration of contrast medium and its first appearance in the bile ducts

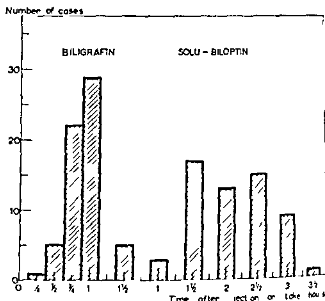


Fig 3 Time between the administration of the contrast medium and its optimal density in the bile ducts

Irrespective of what constitutes adequate contrast density, the figures for the present series — examined in technically the same way and without using any supplementary drugs such as morphine — show that oral cholegraphy has not been equally satisfactory for examining the bile ducts as intravenous cholegraphy Fig 1 shows a typical difference of this type in the contrast density in the bile ducts of one of the cases

As regards the excretion conditions of Solu Biloptin, the present results (Figs 2 and 3) concur with those of SALTZMAN (1960) In nearly three fourths of the cases the first signs of contrast medium in the ducts were noted one hour after the medium had been swallowed Optimal contrast density was reached in all but one case within 3 hours, for the majority of the cases the time was 1 1/2 to 2 1/2 hours

In two thirds of the oral group accumulation of the contrast medium in the prepyloric part of the stomach or in the duodenum interfered in some degree with the interpretation of the roentgenogram This, however, was true chiefly of films obtained during the first hour In all but a few of the 2 hour roentgenograms the residual contrast medium had disappeared

Side effects The reactions of the patients given a slow and a rapid injection of Biligrafin showed fair correspondence They are combined in Table 1 which indicates that the reactions were somewhat more numerous than SALTZMAN

Table 1

Reactions in patients given injections of Biligrafin as compared with injections of Solu Biloptin

	Biligrafin	Solu Biloptin
Number of cases	62	61
No reaction	35	50
Nausea	13	5
Vomiting	7	3
Urticaria	2	nil
Headache	1	1
Abdominal pain	2	2
Sneezing	1	nil

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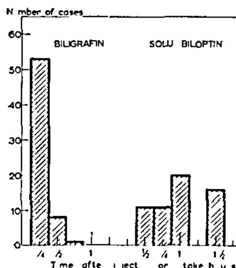


Fig 2 Time between the administration of contrast medium and its first appearance in the bile ducts

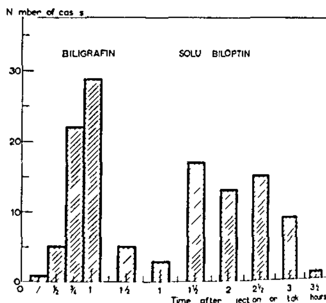


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Table 1

Reactions in patients given injections of Biligrafin as compared with injections of Solu Biloptin

	Biligrafin	Solu Biloptin
Number of cases	69	61
No reaction	35	50
Nausea	13	5
Vomiting	7	3
Urticaria	2	nil
Headache	1	1
Abdominal pain	2	2
Sneezing	1	nil

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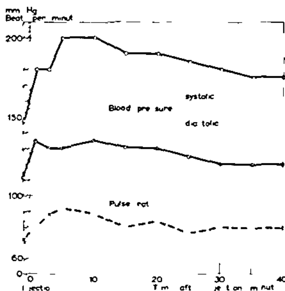


Fig 4 Rapid injection of Biligrafin forte Marked and rather rapid increase in blood pressure with moderate tachycardia and slow return of heart rate to initial values

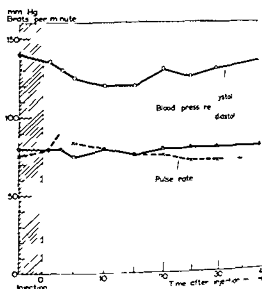


Fig 5 Blood pressure and pulse rate after slow injection of Biligrafin forte 16 % fall in systolic blood pressure and concomitant moderate tachycardia The diastolic pressure was unusually little affected

Twenty of the 30 rapidly and 30 of the 32 slowly injected cases showed a fall in systolic pressure which was more than 10 % in 3 and 12 cases, respectively The diastolic pressure usually fell by a corresponding percentage whereas the pulse rate mostly rose initially and then, towards the end of the observation period, was lower than the starting level The fall in the blood pressure began within a few minutes of completing the injection and the lowest value was recorded after 10 to 20 minutes A slow rise then followed which in most cases was not complete at the end of the recording period (Fig 5) No manifest difference was found in the course of the fall between the rapid and the slow injection The mean age of the 15 patients whose blood pressure fell more than 10 % was 48 years, the mean age of the total series being 49 years Ten of these patients had reactions which exceeded the mean percentage for all the patients

The pulse rate rose on an average by 18 % in the cases given the rapid injection but the increase was only 13 % with the slow injection The mean subsequent fall in the pulse rate in intravenous cholegraphies was 5 % and 6 %, respectively

A dangerous complication arose in a woman of 36 who mentioned that she was oversensitive to penicillin and streptomycin and was given a Biligrafin injection in 4 minutes Three minutes after the injection was over she experienced nausea, became extremely pale, broke out in a cold sweat and became somnolent At the same time the systolic blood pressure dropped to 50 mm Hg



Fig 6 Blood pressure and pulse rate during peroral cholegraphy with [illegible] g Solu Biloptin The blood pressure which had not risen after one hour showed a slow but marked decrease No noteworthy effect on the pulse rate

and 2 min later could not be registered at all The reaction was controlled in 10 min with the aid of Aramine and Solu Cortef It was decided not to perform a peroral examination of this patient Deaths have been reported in connection with the use of Biligrafin by FROMMHOLD & BRABAND (1960) and a fall in blood pressure has in all probability been one of the most essential contributory factors in such fatalities

Peroral cholegraphy An elevation of systolic blood pressure occurred in about a third of the cases but it was over 10 % in only 3 out of 61 cases The mean elevation was only 2 %

Both the systolic and the diastolic pressure fell in about two thirds of the cases The drop in systolic pressure was greater than 10 % in 10 patients average 9 %, a corresponding fall in diastolic pressure occurred in 20 patients mean 8 % If the systolic pressure fell by more than 10 % a similar drop was always established in the diastolic pressure

A fall in blood pressure was definitely more slow to occur in the peroral than in the intravenous studies It was found to persist for at least an hour and in some random controls until the following day An example of this type of blood pressure reaction is shown in Fig 6 All the changes described above are collected in Table 2

Discussion

When the present investigation was commenced little and often contradictory information was available in the literature concerning the suitability of the new oral cholegraphy preparation Solu Biloptin for biliary duct diagnosis The authors had not come across any direct comparison of Solu Biloptin and Biligrafin forte

The diagnostic results were without any doubt in favour of intravenous cholegraphy in the present series which were studied by exactly the same roentgen technique SALTZMAN was of the opinion that the preparations demonstrated the bile ducts equally well The discrepancy between his view and the present finding can perhaps be accounted for at least to some extent by the fact that SALTZMAN used morphine regularly and in most cases tomography as well

Table 2

Changes in blood pressure and pulse rate as observed in the whole material

Preparation	Total of cases	Systolic pressure				Diastolic pressure				Pulse rate			
		Rise		Fall		Rise		Fall		Rise		Fall	
		max	mean	max	mean	max	mean	max	mean	max	mean	max	mean
Biligrafin < 1 min	30	52	9	38	6	70	7	29	5	80	18	17	5
Biligrafin ≧ 4 min	32	43	4	70	11	20	3	70	11	56	13	20	6
Solu Biloptin	61	22	2	24	5	22	8	28	8	26	5	20	3

On the other hand, the authors agree with SALTZMAN that the excretion of Solu Biloptin is sufficiently rapid and reasonably constant in speed In the majority of the cases excretion of the contrast medium could be seen within 1 hour of its ingestion and an optimal contrast density could be expected in the bile ducts after about 2 hours Non resorbed contrast medium was disturbing chiefly during the less important early part of the examination Reactions after the administration of Solu Biloptin were few in number

On the point of blood pressure changes the present authors experience again diverged from the observations of SALTZMAN & SUNDSTROM probably because the latter performed mainly intra arterial pressure measurements on a fairly small series for a relatively short time, whereas we used the conventional cuff method for a longer period on a somewhat larger series The most marked changes recorded by SALTZMAN & SUNDSTROM in intravenous cholegraphies were a rapid drop in blood pressure lasting for a few minutes only — a mean fall in systolic pressure of 15 % — followed by an increase in the pulse rate

The majority of the present cases responded with a fall in blood pressure of about 11 % systolically after a slow injection A rapid injection lowered the pressure by 6 % only These findings are completely at variance with the observations of the authors cited The maximum fall usually occurred 10 to 20 min after the termination of the injection The mean age of the patients displaying an especially great decrease did not differ from the mean for the total series but the number of reactions increased

The present authors also observed an elevation in blood pressure averaging 9 % especially in connection with rapid injections It was usually accompanied by a major increase in the reactions of one type or another

The blood pressure changes were considerably smaller with oral cholegraphy However, the diastolic fall which reached as high an average as 8 % is worthy

of note The fall with the oral method was more protracted than with the intravenous

The results seem to underline the importance of regarding blood pressure changes as a potential dangerous complication of intravenous cholegraphy The authors agree fully with the assumption of SALTZMAN & SUNDSTROM that a lowering of the blood pressure after intravenous cholegraphy has been one of the essential contributory factors in the fatalities which have occurred, principally among aged patients and those with a cardiac condition Such cases should be examined by peroral cholegraphy, though even this technique appears occasionally to produce a clinically significant fall in blood pressure Because of these blood pressure reactions the present authors suggest that a routine recording of the blood pressure is a reasonable precaution before administering the contrast medium both in intravenous and oral cholegraphy as it may give a forewarning of potential complications

SUMMARY

Intravenous cholegraphy with Biligrafin forte and oral cholegraphy with Solu Biloptin were performed on the same unselected cases 61 in all The bile ducts were better demonstrated by the intravenous method although this produced considerably more reactions of a general nature including important changes in the blood pressure

ZUSAMMENFASSUNG

Die intravenöse Cholegraphie mit Biligrafin forte sowie die orale Cholegraphie mit Solu Biloptin wurden beide in 61 nicht ausgewählten Fallen durchgeführt Die Gallengange wurden mit der intravenosen Methode besser dargestellt Hierbei traten jedoch viel haufiger Allgemeinreaktionen einschliesslich bedeutender Blutdruckschwankungen auf

RÉSUMÉ

Les auteurs ont pratiqué sur les mêmes 61 cas non sélectionnés une cholégraphie intraveineuse par la Biligrafin forte et une cholégraphie orale par la Solu Biloptin Les voies biliaires ont été mieux mises en évidence par la méthode intraveineuse mais celle ci a eu beaucoup plus d effets secondaires d ordre général parmi lesquels d importantes modifications de la tension artérielle

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ACTION OF BILIGRAFIN FORTE ON THE RAT LIVER

by

Y EDLUND and L ZETTERGREN

The present investigation was performed to determine the effect of the administration to rats of large doses of Biligrafin forte (the methylglucamine salt of N N[1] adipin di (3 amino 2,4 6-tri iodobenzoic acid) A previous study of the toxic action of biliary contrast media containing four iodine atoms (the methyl glucamine salt of tetra iodophthalic acid morpholide) in which control rats were given either physiologic saline or Biligrafin forte (EDLUND & ZETTERGREN 1961) by the peritoneal route disclosed that some of the animals given the latter drug developed liver changes characterized by an abundance of mitoses

Material and Methods The material for study comprised 89 albino rats of both sexes with a bodyweight between 200 and 300 g from the Sprague Dawley strain They were maintained on an unrestricted diet of ordinary rat bread and water The rats lived in two different pens and were divided into three groups Group I (34 rats) and group III (5 rats) were kept in one pen and group II (50 rats) in a separate pen It should be mentioned that unlike the rats in groups I and III those in group II in addition to the basic diet received two weekly supplements of milk containing an adequate dose of vitamins A and D both during the rearing period and during the experiment if the latter lasted any length of time

Intraperitoneal Biligrafin forte doses of varying number and size were administered to 84 of the 89 rats

Group I Twenty nine of the animals received Biligrafin forte injections on 3 consecutive days in the following doses per 100 g bodyweight 150 mg (19 rats) 75 mg (5 rats) and 37 5 mg (5 rats) These rats were all decapitated on the 4th day The remaining 5 rats in this group all received a total dose of 150 mg per 100 g bodyweight but were decapitated one month after the last injection

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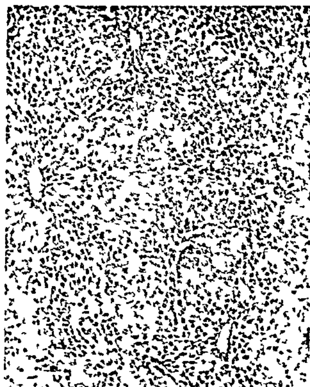


Fig 1 Liver showing extremely discrete peripheral necrobiosis with accentuation of the lobular structure Hematoxylin van Gieson

Group II The rats were given Biligrafin forte and killed in accordance with the following schedule (doses specified per 100 g bodyweight)

1 150 mg on three consecutive days the animals being killed on the 4th day (10 rats)

2 Single doses of 150 175 200 225 and 250 mg to each of two rats the animals being killed the following day (10 rats)

3 Single doses of 150 mg the animals being killed 1 2 3 4 5 and 6 hours after the injection (6 rats)

4 Daily doses of 150 mg on 35 consecutive days the animals being killed on the 36th day (12 rats)

5 Daily doses of 150 mg for 35 consecutive days the animals being killed 5 months after the last injection (12 rats)

Group III comprised 5 control rats given daily doses of 0 3 ml sterile physiologic saline on each of three consecutive days and killed on the 4th day

Without exception the rats were killed by decapitation At autopsy the liver and in most cases the pancreas spleen and lungs were saved for microscopic examination The liver spleen kidneys thyroid glands and thymus from the rats in group II 4 were weighed The specimens were fixed in 10 % formalin solution and/or in Zenker s medium and occasionally in absolute ethanol they were embedded in paraffin in the usual mann r sectioned and stained with hematoxylin eosine and hematoxylin van Gieson Some liver sections were stained according to Feulgen or with orceine-methylene blue for the demonstration of mitoses and by Best s procedure for showing glycogen



Fig 2 Liver showing extensive peripheral necrobiosis necrosis Hematoxylin van Gieson

Results

Group I It appeared at autopsy that the majority of the 19 rats given three 150 mg injections of Biligrafin forte and decapitated on the 4th day had an abnormally pale liver, which was occasionally yellowish Microscopic inspection disclosed slight necrobiosis in the peripheral lobes of the livers from 4 of the rats causing the lobular structure to appear more marked than normally (Fig 1) Moreover particularly in these regions the liver cells presented evidence of edema (hydropic degeneration) The livers from 6 other rats exhibited considerably more advanced lesions in the form of extensive peripheral necrobiosis or even necrosis (Fig 2) The altered liver cells were rounded and had a structureless strongly acidophil protoplasm with the pyknotic nucleus displaced peripherally (acidophil degeneration) (Fig 3) The liver cells were in places completely destroyed These 10 rats had a remarkably large profusion of liver cells in varying stages of mitosis (Fig 4) The mitoses occurred in intact portions of the liver were seldom atypical and exhibited neat spindles in metaphase (Fig 5) The liver from another rat displayed a large number of cells in mitosis but was otherwise free from significant abnormalities

In two livers with extremely mild changes and in two with marked lesions the number of mitoses was counted in 100 fields of given size (objective 40 ×

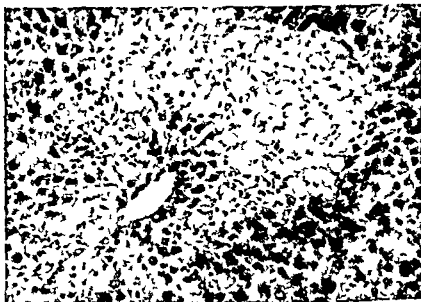


Fig. 3. Part of a liver lobule showing acidophil degeneration. The cytoplasm of the rounded hepatic cells is hyalinized and strongly acidophilic. Hematoxylin van Gieson.

binocular eye pieces 10 ×). The liver surface had an area of some 25 mm² and the total number of examined cells was approximately 5 000 per rat. The mitotic index — that is the number of mitoses per 100 fields — for the two livers with mild changes was 84 and 245 and that for the two livers with marked lesions 43 and 116 respectively.

In rats given 75 and 37.5 mg Biligrafin forte on three consecutive days, there was hydropic degeneration of the liver cells but only a small number of mitoses.

No significant changes were observed in the livers from the 5 rats killed a month after receiving 150 mg Biligrafin forte on three consecutive days.

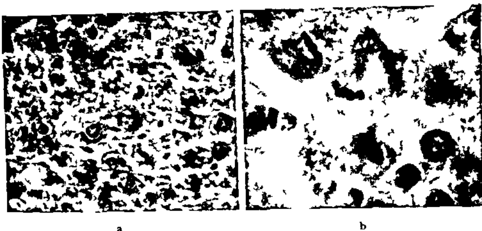
The other organs in this group displayed no noteworthy changes.

Group II. Apart from a few mitoses in occasional rats, no significant liver changes of the type characterizing group I were encountered in livers from those rats that, like the large majority of animals in group I, received 150 mg Biligrafin forte on three consecutive days and were decapitated on the 4th day (group II: 1). In group II: 4, in which the liver and other organs were weighed at autopsy, some of the liver weights observed were found to be considerably greater than the corresponding estimated weights as given in the Table on p. 118.

Group III. The livers from all 5 rats displayed a normal structure.

Discussion

It appeared that rather more than half the rats in group I that received 150 mg per 100 g bodyweight Biligrafin forte intraperitoneally on three consecutive days and were decapitated on the 4th day exhibited marked liver lesions of the



a b

Fig 4 Different magnifications of well preserved hepatic tissue with numerous mitoses Hematoxylin van Gieson

degenerative type The absence of primary inflammatory changes as well as the location of the degenerative changes within the lobules of the liver suggest that the latter were induced by an agent exerting a toxic action on the liver Since similar changes could not be observed in the livers from the control rats that had received intra peritoneal injections of physiologic saline it is reasonable to assume that the contrast medium was responsible for the toxic degenerative lesions of the liver

The high incidence of mitoses observed is remarkable It has long been recognized that the rat liver possesses exceedingly strong regenerative powers (PONFICK 1890 VON MEISTER 1894 inter alios) Thus some 7 or 8 days after surgical removal of three quarters of the liver the organ has regained its pre operative weight The regeneration is manifested by an increased number of mitoses In agreement with previous investigators (BRUES & MARBLE 1937, MARSHAK & BYRON 1945 inter alios) BLOMQVIST (1957) found that the mitotic index peaked during the second day after partial hepatectomy with a mitotic index of 5 9 (objective 40 × binocular eye pieces 10 × 7 rats) This initial regenerative phase is succeeded by a second one during which the liver exhibits necrotic foci and secondary regenerative activity Mitoses are also apparent during this phase (WILSON et coll 1953) The normal liver structure is generally restored 6 to 8 weeks after partial hepatectomy when the mitotic index again becomes the same as in a normal adult rat i e zero In the light of these data our experiments would appear to indicate that the marked acceleration of the mitotic rate observed was a sign of regeneration resulting from the degenerative lesions of the liver However the regenerative activity was remarkably high and in terms of the mitotic index was up to forty times as great as after partial hepatectomy As a consequence of this high mitotic rate — equalled only in the

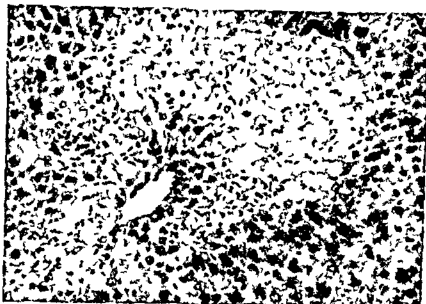


Fig. 3. Part of a liver lobule showing acidophil degeneration. The cytoplasm of the rounded hepatic cells is hyalinized and strongly acidophilic. Hematoxylin van Gieson.

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Fig 5 Hepatic cell mitosis in metaphase

showed that biliary contrast media influence the oxygen consumption of the liver by inhibiting the oxygenoferrous enzymes Moreover about one third of all human subjects given Biligrafin forte have side effects, including gastrointestinal disturbances (SALTZMAN 1959) and graver manifestations, such as circulatory failure and even death have also been reported In certain circumstances therefore the compound exerts a toxic action

SUMMARY

The results of an investigation into the effects of administering large doses of Biligrafin forte in a material of 84 albino rats are reported About half the animals were found to have developed zonal necrobiosis of the liver with a mitotic index of up to 245 The results were not reproducible in a control material and it is suggested that reduced resistance of the liver parenchyma may have been the primary cause of the degeneration

ZUSAMMENFASSUNG

Das Ergebnis einer Untersuchung uber die Wirkung grosser Dosen von Biligrafin forte in einem Material von 84 Albinoratten wird berichtet Man fand dass etwa die Halfte der Tiere eine zonale Nekrobiose der Leber mit einem Mitosenindex von bis zu 245 entwickelten Diese Ergebnisse konnten in einem Kontrollmaterial nicht reproduziert werden und es wird angenommen dass eine Resistenzherabsetzung des Leberparenchymes der primare Grund der Degeneration gewesen sein möge

RESUMÉ

Les auteurs présentent les resultats d une expérimentation sur les effets de l administration de fortes doses de Biligrafin forte sur une série de 84 rats albinos Ils ont constaté qu environ la moitié de ces animaux présentaient une nécrobiose zonaire du foie avec un indice mitotique atteignant 245 Ces résultats n ont pu etre reproduits sur des animaux de contrôle Ies auteurs pensent que la cause primaire de cette dégénérescence peut avoir été une diminution de la résistance du parenchyme hépatique

Table

Liver weights of rats given 150 mg Biligrafin forte intraperitoneally on 35 consecutive days and killed on the 36th day (group II 4)

Rat No	Observed	Estimated
38	8	7 5
39	10	7 9
40	8	8 1
41	9	8 1
42	9 5	7 8
43	8 7	8 1
44	17	11 2
45	15	11 1
46	19	13 2
47	18	12 3
48	16	11 0
49	18	11 8

most rapidly growing types of tumour — several contiguous liver cells in the same slide were often seen in mitosis (Fig 4b) Another interesting fact is that the mitotic appearances were more distinct than those evident in the liver after partial hepatectomy, having clearly delineated spindles and plainly visible chromosomes in the metaphase

It was noteworthy and indeed perplexing that such liver changes as were displayed by some of the rats from group I could not be reproduced in similarly treated rats from group II, the latter group actually being intended to form the basis for further studies of the liver changes, with particular attention to their subsequent progress It had seemed a stimulating possibility that bloodless partial hepatectomy might provide regenerative activity in the liver and it would be possible to estimate the intensity of the regeneration at various stages in its development from changes in the mitotic rate However, as mentioned, the only constant abnormality in group II was a comparatively speaking slight increase in the number of liver cells in mitotis and in rats undergoing long term treatment, marked liver hypertrophy The latter should probably be taken as a sign of increased liver stress owing to the repeated Biligrafin forte injections

The fact that the lesions in group I could not be reproduced in group II cannot be adequately explained at the present time The most likely explanation seems to be that for some reason the rats in group I were more susceptible to the contrast medium than those in group II Such an increased vulnerability of the liver could perhaps be due to a deficiency state As stated previously, the diet of the rats in group II was supplemented with vitaminized milk twice weekly and that of the rats in group I were not Another conceivable explanation is that a latent viral infection might have altered the metabolism of the liver cells in the latter group It is recalled that an investigation by WINZER et coll (1954)

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JOINT CHANGES IN PSORIASIS

by

G. Csákány, S. Bozsoky, L. Bakos and S. Korossy

Joint changes associated with psoriasis, which were first described by Bourdillon in 1888, have always aroused a fair amount of controversy. There appear to be four schools of thought as to their nature.

I. The joint involvement has the same aetiology as psoriasis, i. e. psoriasis may present an articular manifestation (Coste et coll. 1958, Wright 1956).

II. The development of chronic polyarthritis in psoriasis may be coincidental (Coste et coll., Hench and Wright 1959).

III. Psoriasis may be associated with acute rheumatic fever with chronic polyarthritis secondary to the latter (Church 1958).

IV. Although psoriasis and chronic polyarthritis may occur together as separate entities, the former modifies the latter.

The present investigation was undertaken with a view to determining the nature of the joint condition, special consideration being given to the roentgenologic appearances.

Material and Methods. The cases were divided into four groups. Group I consisted of 54 cases of psoriasis with joint signs, group II of 50 cases of psoriasis but without joint signs (these two groups were collected at random until the 54 psoriasis cases with joint involvement were assembled), group III of 50 cases of typical primary chronic polyarthritis (rheumatoid arthritis) without dermatologic disease and group IV consisted of 50 non-psoriatic dermatologic cases.

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Fig 2 Narrowed articular space of distal interphalangeal joint of second finger of right hand The joint surfaces are broken and partly ankylosed and the periosteum of the middle phalanx is thickened Normal calcium content of the bones

(c) Arthritis (11 cases) these cases had clinical and roentgenographic evidence of arthritis

Five cases of group I c had chronic polyarthritis or ankylosing spondylitis (Fig 1) The remaining 6 cases of this sub group appeared to present evidence of a separate roentgenologic entity with the following characteristics (Figs 2 3 and 4) The involvement was asymmetric and only a few joints were affected, the typical sites of election being the distal interphalangeal joints of the hand and feet In chronic polyarthritis the proximal interphalangeal and the metacarpophalangeal joints are most often involved Notwithstanding the presence of inflammatory and destructive changes the bones were not demineralised, a slight loss of density occurred in a patient aged 76 but this was apparently due to senile osteoporosis Considerable demineralisation is a prominent feature in chronic polyarthritis Marked disorganisation of the joint with fragmentation fringing and extensive destruction of the cartilage together with subchondral rarefaction were evident This occurs mostly only in the advanced stages of chronic polyarthritis Muscular contracture and periarticular soft tissue swelling as in advanced chronic polyarthritis, were rather common (Table 2)



Fig. 1. Marked deformities and subluxations of joints of hand. Extensive destruction of the distal interphalangeal joints of the right second and fifth and left fourth fingers; articular surfaces of other joints mostly normal

The following tests and examinations were performed in addition to the usual clinical investigations: the Waaler-Rose test at the onset of treatment (Kovács & Bozsoky 1959), determination of the ASO titre on 2 or 3 occasions at weekly intervals (Bozsoky 1959), C-reactive protein (CRP) tests at the same time as the ASO titrations (Gál & Miltényi 1955), roentgenologic examination of both hands and feet as well as all of the joints causing symptoms or exhibiting signs.

Results

The principal findings are given in Table 1. It was found that group I could be divided into three sub-groups exhibiting different well-defined clinical entities:

(a) Arthralgic (13 cases): these complained of articular pain but presented no evidence of clinical or roentgenographic abnormality.

(b) Arthrosis (degenerative changes) (30 cases): joint symptoms accompanied by clinical and roentgenographic evidence of ordinary arthrosis.

Table 1 *(cont.)*

ASO titre			CRP test		ESR		No change	Roentgen diagnosis		
under 100	100 to 200	over 200	under 1:150	over 1 in 1:150	under 20 mm/1 hr	higher than 20 mm/1 hr		arthrosis	chronic polyarthritis	psoriatic arthritis
2	11	0	11	2	9	4	13	—	—	—
8	16	6	27	3	17	13	—	30	—	—
2	5	4	8	3	4	7	—	—	5	6
12	32	10	46	8	30	24	13	30	5	6
24	18	8	43	7	37	13	41	9	—	—
36	50	18	89	15	67	37	54	39	5	6
39	7	4	26	24	7	43	—	—	50	—
7	10	6	21	2	13	10	23	—	—	—
11	9	7	25	2	16	11	—	25	2	—
18	19	13	46	4	29	21	23	25	2	—

that MEANEY and HAYS (1957) have also called attention to these two types of psoriatic arthritis.

The case of group I b presented no characteristic clinical or roentgenographic features. The average age of the patients was 51.7 years and, at the time of onset of joint symptoms, was 43 years, when arthrosis usually begins to occur. None of the patients under 30 in this group had joint symptoms. No evidence was found to suggest that the dermatologic changes and arthritis could be traced back to a common aetiology.

Group I a merits however more attention. The average age of the patients at examination in this group was 31.9 years and that at onset of symptoms was 26 years. The average duration of the psoriasis was 6 years, and that of joint symptoms was 5 years. In general, no clinical or roentgenographic signs were observed in these patients. But when it is realized that the average

Table 2

Roentgenologic changes in joints in psoriatic arthritis

Number of cases	Localization		Ca content		Joint destruction		Deformities		Soft tissue changes	
	asymm.	symm.	reduced	norm.	present	absent	pres.	abs.	pres.	abs.
6	6	0	1	5	6	0	4	2	5	1
5	0	5	5	0	3	2	2	3	3	2

Table 1

Principal findings in the various tests and examinations

		Number of cases	Average age			Psoriatic nails	Waaler Rose test
			at exam	at onset of psor	at onset of joint sympt		
Group I							
	(a) Arthralgia	13	31 9	25 2	26 0	4	0
	(b) Arthrosis	30	51 7	33 7	43 0	19	0
	(c) Arthritis	11	57 6	38 3	34 3	10	1
	Total	54	51 8	32 5	31	34	1
Psoriatic control		50	39 3	27 2	—	24	0
	Psoriatic total	104	44 8	29 9	—	58	1
Chronic polyarthritis control		50	51 0	—	33	—	34
Mixed dermatologic material	(a) No joint signs	23	28 4	—	—	—	1
	(b) Joint signs	27	55 7	—	44	—	1
	Total	50					2

It would appear from a survey of the literature (Boni 1957, Coste et coll, Sherman 1952, Weissenbach 1949, and Wright 1957 and 1959) that these appearances are commonly encountered in association with psoriasis

Discussion

Boni divided arthritis occurring in psoriatic subjects into three types arthralgic, degenerative and inflammatory Our investigations confirm the validity of this view

We consider the inflammatory group to be the most important The 11 cases in our I c (arthritis) group presented certain constant characteristics The psoriasis at the time of the examination was associated with signs and symptoms of inflammation of the joints No matter which appeared first, the psoriasis or arthritis exacerbations occurred simultaneously The nails showed evidence of psoriatic changes in 10 of the 11 cases The Waaler Rose test was negative (only in one case was it nearly positive) Roentgenographic indications of inflammation were found mainly in the joints of the hands and feet Distinction could be made between 6 cases exhibiting changes peculiar to psoriatic arthritis and 5 cases showing changes more similar to those found in chronic polyarthritis However, the clinical signs and serologic tests indicated that even the latter may not be cases of true chronic polyarthritis but cases in which psoriasis produced articular manifestations It may be mentioned



Fig 4 Characteristic changes in the left 1st 4th and 5th toes and the right 4th and 5th toes The joint surfaces of the distal interphalangeal joints are hazy and broken up and the subchondral zone of calcification has disappeared Erosion of the left big toe Widened joint spaces of right 4th and 5th toes.

68 per cent of cases of chronic polyarthritis was negative in all but one of our psoriatic arthritis cases

It is suggested in view of these findings that the term psoriatic arthritis is more suitable than the usual designation psoriatic arthropathy

SUMMARY

Characteristic joint changes that were observed in arthritis associated with psoriasis or psoriatic arthritis in a material of 54 cases with adequate controls are described The condition is discussed with special reference to the differential diagnosis of chronic polyarthritis

ZUSAMMENFASSUNG

Karakteristische Gelenkveranderungen welche bei mit Psoriasis kombinierter Arthritis oder Psoriasisarthritis in einem Material von 450 regelmassig nach untersuchten Fallen beobachtet worden sind werden beschrieben Die Krankheit wird unter besonderer Berucksichtigung der Differentialdiagnose chronischer Polyarthritis besprochen

RÉSUMÉ

Les auteurs décrivent les lésions articulaires caractéristiques observées dans 54 cas contrôlés d arthrite accompagnant le psoriasis dite arthrite psoriasique Les auteurs étudient cette affection en particulier au point de vue de son diagnostic différentiel avec la polyarthrite chronique

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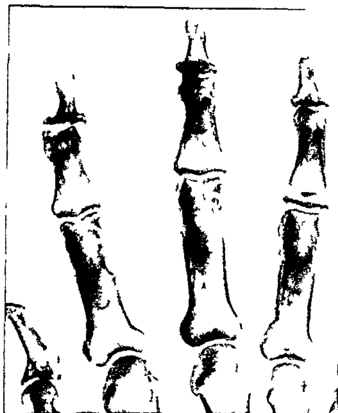


Fig 3 Hazy broken articular surfaces of distal inter phalangeal joint of right index finger Subluxation ulnar deviation and soft tissue swelling

duration of psoriasis was 19 years and that of joint symptoms was more than 22 years in the group I c patients, there may be some justification in pre suming that arthritis was yet to appear in the patients of group I a

Conclusions

There appears to be evidence to suggest that psoriatic arthritis is an in dependent entity

Inflammatory joint conditions are relatively often associated with psoriasis and the incidence of arthritis and arthralgia in young subjects with psoriasis The skin and joint conditions usually appear together and ungual psoriasis may be accompanied by changes in the distal interphalangeal joints

There appear to be characteristic roentgenologic joint changes in psoriatic arthritis distinct from those encountered in chronic polyarthritis The changes appear asymmetrically in single joints and these show evidence of marked destruction of cartilage with periarticular swelling Osteoporosis is never a prominent feature Furthermore, the Waaler-Rose test, which is positive in

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STRUCTURAL CHANGES IN THE WALL OF THE AORTIC ARCH

I Morbid anatomy and roentgenologic control

by

F DALITH

In a previous publication (8) it was shown that calcification of the aortic knob in elderly subjects is a manifestation of selective deposition of calcium in the wall of the aorta at the levels of (1) the insertion of the ligamentum arteriosum and (2) the origin of the left subclavian artery Examination of 100 aortic arch specimens revealed the constant presence of two depressions on the intimal surface of these segments Protrusions were frequently seen at these sites on the adventitial surface of the media These areas showed increased translucency when viewed by transillumination and were the sites of calcified plaques when such were demonstrable roentgenologically It was concluded that the structural changes described are concerned with the aortic connections of the sixth and most probably the fifth embryonic aortic arches

It is the purpose of this paper (1) to report additional observations on structural changes in the wall of the aortic arch (2) to point out the similarity in the location of calcifications and the sites of coarctation of the aorta and (3) to discuss the possible common origin of both lesions

This report is based on further studies of the morbid anatomy with roentgenologic control of the 100 specimens of the aortic arch which constituted part of the material of the previous publication (8)

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Fig Sp c m n of aortic a ch f om male ged 0 a Int mal urfac botall an de p ess filled up b th romat us plaque b Trans llum n ted pec men ather ma at botall n level appe rs a opa ity D pression at ubclav a l v l incr as d tran lucency o) at ts entral p rt c) Roentg nogr m two lc f c t ons th o e at sub lavian level l rgest dorsally

Fig 3 Specimen of ao tic arch from male aged 70
a) Int mal surface botallian depress on appears a a mall d mple only
b) Trans llum nated spec men increased tra s lu ency only at subclavian level
c) Roentg nogram two calc fications
▽ Le el of o igin of left subcla ian artery
▼ Level of inse tion of l gamentum arteriosum



a) Intimal surface two depressions



b) Transilluminated specimen two areas increased translucency



c) Roentgenogram two calcifications



d) Adventitial surface two protrusions

Fig 1 Specimens of aortic arch from female aged 79 ▽ Level of origin of left subclavian artery ▼ Level of insertion of ligamentum

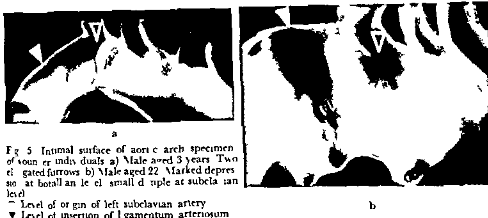


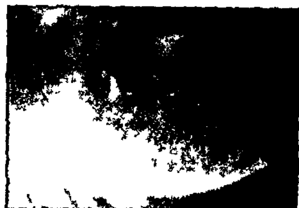
Fig 5 Intimal surface of aortic arch specimens of younger individuals a) Male aged 3 years Two elongated furrows b) Male aged 22 Marked depression at botallian level small dimple at subclavian level
‾ Level of origin of left subclavian artery
▼ Level of insertion of ligamentum arteriosum

by transillumination (Fig 2b) In others the translucency is equal to that of the surrounding aorta (Fig 2b) in spite of the presence of a gross calcium deposit within an area of depression A large calcium plaque may be present in a small dimple (Fig 3c) and no calcification may be found in a deep depression (Fig 4c) In specimens from young subjects increased translucency is less marked and calcium density practically does not occur (Fig 5) At least one of these structural changes was always found the most constant being the intimal depression The size and depth of the depression seem to increase with age The lesions are always located in the ventral and left lateral wall of the aorta

Positions of the calcifications Calcified opacities in the wall of the aortic arch vary in position The ventral end of the subclavian calcification is constantly located opposite the origin of the left subclavian artery (Fig 6 a to e) Its dorsal end on the other hand may be situated directly opposite (Fig 6b) or more proximal (Fig 6a) or more distal (Fig 6c) to it Similarly, the ventral end of the botallian or ductus arteriosus calcification is constantly located at the point of insertion of the ligamentum arteriosum (Fig 6 a to e), while its dorsal end may be directly opposite (Fig 6e) or more proximal (Fig 6d) or more distal to it (Fig 6b) The various positions of the calcium densities in the left wall of the aortic arch are illustrated diagrammatically in Fig 6f

Discussion

We believe that the structural changes in the aortic wall represent the sequel of a scarring process at the sites of connection of the fifth and sixth embryonic arches subsequent to the disappearance of the former and the closure of the latter It would seem that the constant location of the changes



a) Intimal surface very deep botallian depression



b) Transilluminated specimen two areas of increased translucency



c) Roentgenogram no calcification at botallian level spot like calcified plaques at subclavian level

Fig 4 Specimen of aortic arch from female aged 67

Varying appearances of the structural changes Not all of the structural changes (deformity of the wall, increased translucency and calcification, Fig 1) are always apparent There are specimens in which a depression is filled by an atheromatous plaque (Fig 2a) so that it appears as an opacity when viewed

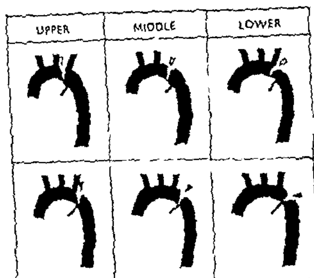


Fig 7 Sites of main types of coarctation of aorta
Upper row subclavian lower row botallian

on the left side is explained by the fact that in mammalia the left embryonic aortic arches are connected to the lateral wall of the left dorsal aorta (14) The increase in size of the intimal depressions and adventitial protrusions with age may be the result of progressive weakening of these poorly vascularized areas by atherosclerotic changes in the vasa vasorum of the aorta Localized increased translucency is related to thinness of the aortic wall at these points It would appear that the deposition of calcium marks the final stage of this dystrophic process (Histologic studies of these segments of the aortic arch of all age groups are at present in progress and the results will be reported at a later date)

Structural changes in the wall of the normal aortic arch and coarctation of the aorta Coarctation of the aorta shows two sites of predilection (1) at the level of the origin of the left subclavian artery and (2) at the area of the insertion of the ligamentum arteriosum (or the entrance of a patent ductus arteriosus) Various designations have been chosen by authors for these two main types of coarctation such as *infantile* and *adult* (5) preductal and ductal (11) isthmique and botallique (14) pre isthmic and isthmic (7), fifth stenosis and sixth stenosis (9) In what follows we intend to designate them as subclavian and botallian coarctation

Each of these types demonstrates three main anatomic variants (Fig 7), depending upon whether the narrowing is located proximal opposite or distal to the origin of the left subclavian artery or the insertion of the ligamentum

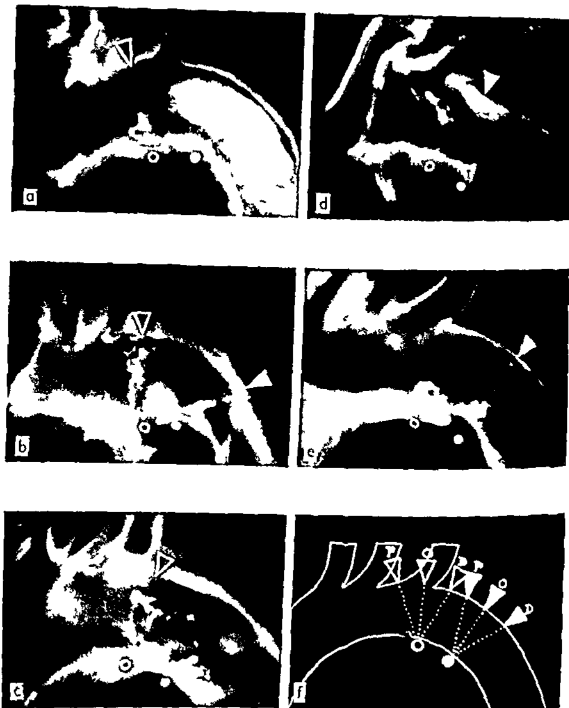


Fig 6 Roentgenograms of aortic rch specimens showing variations in position of elongated calcifications in left wall a) Dorsal end of subclavian calcification ( ) proximal (P) to its ventral end (○) between origins of left carotid artery and left subclavian artery b) Dorsal end of subclavian calcification (▽) opposite (O) to its ventral end ( ) at origin of left sub lavian artery Dorsal end of botallian calcification (▼) distal (D) to its ventral end (●) c) Dorsal end of subclavian calcification (▽) distal (D) to its ventral end ( ) distal to origin of left subclavian artery d) Dorsal end of botallian calcification (▼) proximal (P) to its ventral end (●) e) Dorsal end of botallian calcification (▼) opposite (O) to its ventral end (●) f) Diagram of variants in position of calcifications in left aortic wall

helpful criticism in the preparation of the article Mr J Aidan was responsible for the photographs Fig 1 has earlier been published in Radiology (1961) and the permission to reproduce it is hereby gratefully acknowledged

SUMMARY

Observations on morbid changes in the wall of the aortic arch are reported and their nature discussed Variations in the site of calcium plaques are described The similarity in the location of these calcifications and the sites of coarctation indicates a common denominator in their pathogenesis the remnants of the aortic connections of the fifth and sixth embryonic arches

ZUSAMMENFASSUNG

Beobachtungen uber krankhafte Veranderungen in der Wand des Aortabogens werden berichtet und ihre Natur besprochen Variationen der Lokalisation der Kalkablagerungen werden beschrieben Die Übereinstimmung in der Lokalisation dieser Verkalkungen und der Lage der Coarctatio aortae weisen auf einen gemeinsamen Nenner ihrer Pathogenese namlich die Reste der Aortaverbindungen mit dem 5 und 6 Embryonalbogen hin

RÉSUMÉ

L auteur présente ses observations sur les modifications pathologiques de la paroi de la crosse de l aorte et discute leur nature Il décrit les variations de siege des plaques calcifiées La similitude de la localisation de ces calcifications et du siège de la coarctation indique qu il y a un dénominateur commun à leur pathogénie les restes de implantations sur l aorte des cinquième et sixièm arcs embryonnaires

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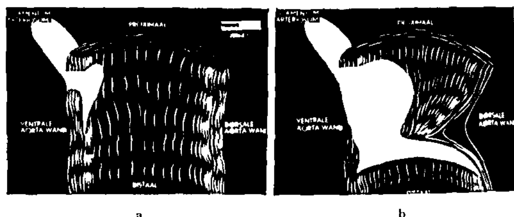


Fig 8 Sections through three dimensional models of aorta at level of insertion of ligamentum arteriosum Courtesy of C Wielenga a) Normal aorta small amount of ductal tissue extending into wall of aorta b) Coarctation of aorta large amount of ductal tissue extending into wall of aorta towards stenosing septum

arteriosum (or a patent ductus), respectively In the subclavian type, strictures of the aorta are reported as located (1) between the left carotid artery and the left subclavian artery, (2) at the level of the origin of the left subclavian artery and (3) immediately distal to the latter In coarctation of the botallian segment, upper, middle and lower stenosis are discerned

The identical sites of selection ('subclavian' and 'botallian') and the similar variations in position ('proximal', opposite and 'distal') of the narrowing of the aorta in coarctation and of the structural changes within the wall of the 'normal' aorta in elderly subjects indicate a common denominator in the pathogenesis of the two lesions The author in a previous paper expressed the opinion that calcification of the aortic knob is the end stage of a dystrophic process at the points of entrance of the primitive fifth and sixth aortic arches Earlier, Costa (7) suggested that implants of embryonic tissue in the aortic wall at the sites of the fifth and sixth arches may be responsible for the appearances of 'pre isthmic and 'isthmic coarctation respectively Wielenga (15) was able to demonstrate abnormally large amounts of ligamentous ductal tissue in the wall of the aorta extending towards the stenosing septum in 'botallian' coarctation (Fig 8) The common etiologic denominator may well be proven by histologic studies if a similar finding is found in the 'subclavian type and in 'double coarctation (a rare variety in which one stricture is located in the subclavian segment and the other in the botallian segment (1, 2, 3, 4, 6, 10, 12, 13) and if normal quantities of non aortic tissue are shown at the sites of selective deposition of calcium in the aortic arch

Acknowledgements

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L auteur présente ses observations sur les modifications pathologiques de la paroi de la cros de l aorte et discute leur nature Il décrit les variations de siège des plaques calcifiées La similitude de la localisation de ces calcifications et du siege de la coarctation indique qu il y a un dénominateur commun à leur pathogenie les restes des implantations sur l aorte des cinquième et sixiem arc embryonnaires

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FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (DIRECTOR PROF SOLVE WELIN),
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NON ULTRAFILTRABLE CONTRAST MEDIUM FOR RENAL ANGIOGRAPHY

by

GEORG THEANDER and LENNART WEHLIN

Renal angiography performed with conventional contrast media is a highly informative method of examination in its arteriographic and nephrographic phases Unfortunately the phlebographic phase is far less satisfactory Minor intrarenal veins cannot be distinguished in the angiograms and even the renal vein is often not well outlined This limitation of the method is all the more unfortunate since no alternative procedure is available to demonstrate the entire renal venous system roentgenographically Selective renal phlebography by retrograde catheterization though useful in the examination of the large veins of the kidney likewise fails to demonstrate the minor intrarenal veins Further development in this field of roentgenology is therefore desirable

Nevertheless the failure so far to obtain a satisfactory phlebographic phase of renal angiography has apparently been neglected No attempt seems to have been made to control or even to reveal the causal factors It would seem reasonable to assume that the rate of renal elimination of the contrast media used may be of essential importance but although the rapid elimination of current angiographic media is recognized its possible relevance to the present problem has apparently escaped attention The existence of such a connexion is however suggested by an experiment on record in which bilateral renal angiography was performed in a dog with simultaneous injection of Miokon into one renal artery and Thorotrast into the other (EDLING & HELANDER 1959) The angiograms were compared to analyze the nephrographic effect of the contrast media used and the conclusions drawn were confined to this

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Fig 1 Selective renal angiography phlebographic phase 10 % iodine Renal vein somewhat better demonstrated with Biligrafin forte (right kidney) than with Urografin (left kidney)

matter, but the differences observed included better demonstration of the renal veins by Thorotrast This finding deserves special attention since Thorotrast is not eliminated by the kidneys In the present investigation contrast media that are eliminated in different ways were studied for their capacity to demonstrate the renal vessels, in particular the veins, after injection into the renal artery

Material and Method Twelve apparently healthy dogs weighing 8 to 29 kg though mostly about 20 kg were used One or both renal arteries were catheterized via the femoral artery under nembutal anaesthesia Contrast medium was then injected through the catheter or catheters and from the commencement of the injection 30 films were taken of the kidneys with a rapid serial film changer As a rule the experiment was repeated several times with different contrast media in varying order On 8 occasions two media were injected simultaneously one into one renal artery and one into the other All together 90 angiographies were performed

The following contrast media were used Urografin 45 % diluted with physiologic saline solution to an iodine content of 10 % or exceptionally 20 % (13 experiments) Biligrafin forte likewise diluted to 10 % or exceptionally 20 % iodine concentration (6 experiments) and LBg 21 a sterile and stabilized emulsion of Lipiodol F (Ethiodol the ethyl ester of the iodinated fatty acid of poppy seed oil) containing 10 % iodine (71 experiments)

Urografin a conventional angiographic medium is rapidly eliminated by the kidneys Biligrafin is eliminated to a lesser extent by this route normally being excreted mainly by the liver after intravenous injection (Langecker et coll 1953 Billion et coll 1955)

LBg 21 is non ultrafiltrable being corpuscular with a maximum particle diameter of about 2 μ in vitro This medium was prepared on request by the research department of AB Leo Halsingborg Sweden All contrast media were given in a dose of 4 ml The dose was injected at a moderate rate to minimize the risk of the contrast medium escaping partially in retrograde direction into the aorta



Fig 2 Selective renal angiography with Biligrafin forte phlebographic phase 20 iodine Better demonstration of veins than in fig 1 but small intrarenal veins masked by nephrographic effect

Results

In the arteriographic phase, no difference was observed between the angiograms obtained with the various contrast media studied provided that the iodine content was equivalent The nephrographic phase was of shorter duration in the Biligrafin than in the Urografin series and still shorter in the LBg 21 series Thus whereas the nephrographic effect of Urografin and Biligrafin forte persisted during the entire phlebographic phase that of LBg 21 vanished so rapidly that it hardly masked the phlebogram All the media had however sufficient nephrographic effect to demonstrate the arrangement of the cortical and medullary structures (Figs 1 2 and 3)

In the phlebographic phase, the renal vein was somewhat better demonstrated with Biligrafin than with Urografin (Fig 1) When the iodine concentration of these media was increased from 10 to 20 % the vessel showed up more distinctly (Fig 2) Irrespective of the iodine content, however the minor intrarenal veins were indistinguishable because of persistence of the nephrographic effect In this respect LBg 21 was essentially different Not only did this medium reach a considerably higher concentration in the venous blood of the kidney but it also afforded an excellent demonstration of minute intrarenal veins since these were *not* masked by the nephrographic effect (Fig 3) Though small the dose given was thus sufficient to explore the arrangement of the renal the interlobar the arcuate the radiant cortical and even the stellate veins The inferior caval vein and some minute veins of the renal pelvis and ureter were also sometimes discernible (Fig 4)

Discussion

The capacity of the contrast media studied to demonstrate the renal venous system following injection into the renal artery apparently varied inversely with the rate of renal elimination Being non ultrafiltrable LBg 21 thus produced an excellent phlebographic phase whereas Biligrafin forte was unsatisfactory in this respect and only slightly better than Urografin A more marked difference between the two last mentioned media might have been expected since Biligrafin is ordinarily eliminated mainly by the liver It should however be observed that the protein fixation of Biligrafin in the blood which

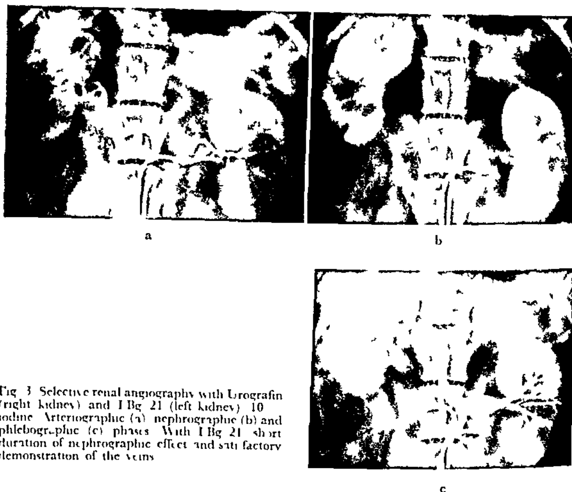


Fig. 3. Selective renal angiography with Urografin (right kidney) and I Bg 21 (left kidney). 10 iodine. Arteriographic (a), nephrographic (b) and phlebographic (c) phases. With I Bg 21 short duration of nephrographic effect and satisfactory demonstration of the veins.

was first observed by LANGECKER et coll. (1953) and which apparently explains why this contrast medium is eliminated mainly by the liver, cannot be expected to occur so rapidly, or to such a degree, as substantially to impair the initial renal elimination after injection into the renal artery (Lajos 1956).

On the whole, the results obtained strongly support the conception that in renal angiography with conventional contrast media satisfactory demonstration of the venous system of the kidney is hampered by the rapid renal elimination of the contrast medium used. This inconvenience is apparently due to the combined action of two undesirable factors. First, the escape of contrast medium from the renal capillaries, being initially exceptionally large on injection into the renal artery, results in a considerably lower concentration of the medium in the venous than in the arterial blood of the kidney. Secondly, the contrast medium in the glomerular ultrafiltrate prolongs and complicates, the nephrographic effect and thereby masks the intrarenal veins. Of these factors, only the first can be compensated for by increasing the amount or concentration of the contrast medium injected. Both are, however, prevented



Fig 4 Phlebograph phase obtained with LBg 21 10 iodine Demonstration of intrarenal ureteral and renal pelvic veins renal vein and inferior caval vein

if the contrast medium used cannot be eliminated immediately by the kidneys The resultant conversion of the nephrographic phase into a purely capillary phase does not seem to impair recognition of the cortical and medullary parts of the kidney but as exemplified by LBg 21 demonstration of the veins is indeed strikingly improved

The addition of a satisfactory phlebogram to the arteriogram and nephrogram in the present experiments with LBg 21 suggests a diagnostic capacity of renal angiography comparable to that of cerebral angiography A non injurious medium with the property under discussion is evidently desirable to effect such improvement in clinical roentgenology Such a medium would moreover be useful for other purposes as well because it would not escape to any appreciable extent into the urine during the examination In selective

angiography of various vascular regions in the abdomen or pelvis it could be repeatedly injected ad libitum, including pilot injections, without undu masking by contrast medium in the kidneys or urinary bladder

No angiographic medium available has both of the properties desired Preliminary experiments with LBg 21 have revealed that injection of moderat amounts of this emulsion into the renal artery can damage the kidney In vestigation of the nature and possible prevention of the untoward effect is in progress

SUMMARY

Urografin Biligrafin forte and finely emulsified Ethiodol were studied for their ability c demonstrating the renal venous system in 90 selective renal angiographies in dogs The ability varied inversely with the rate of renal elimination of the contrast medium A satis factory phlebographic phase was obtained with the non ultrafiltrable Ethiodol emulsion

ZUSAMMENFASSUNG

Urographin Biligraphin forte und fein emulgiertes Ethiodol sind in Bezug auf ihr Fähigkeit das Nierenvenensystem darzustellen bei Hunden in 90 selektiven renalen Angio graphien studiert worden Diese Fähigkeit war der Geschwindigkeit der Nierenausscheidun des Kontrastmittels umgekehrt proportional Eine ausreichende phlebographische Phas wurde mit der nicht ultrafiltrierbaren Ethiodolemulsion erreicht

RÉSUMÉ

Au cours de 90 angiographies rénales sélectives chez des chiens les auteurs ont étudi la mise en évidence du système veineux rénal par l Urografin la Biligrafin forte et l Ethiodc finement émulsionné La qualité de cette mise en évidence est inversement proportionnell a la rapidité de l élimination rénale du moyen de contraste Les auteurs ont obtenu un phase phlébographique satisfaisante par l émulsion non ultrafiltrable d Ethiodol

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AUS DER RÖNTGENABTEILUNG (LEITER: PROF. DR. K. DECKER) DER NERVENKLINIK DER UNIVERSITÄT MÜNCHEN (DIREKTOR: PROF. DR. K. KOLLE), AUS DER MEDIZINISCHEN KLINIK (DIREKTOR: PROF. DR. N. HENNING) UND DEM ANATOMISCHEN INSTITUT (DIREKTOR: PROF. DR. K. F. BAUER) DER UNIVERSITÄT ERLANGEN-NÜRNBERG, DEUTSCHLAND

ABNORME BEWEGLICHKEIT DER OCCIPITO-CERVICALGEGEND BEIM OS ODONTOIDEUM

von

HANS LUDWIG KELLER und AXEL NEISS

Ein selbstständiges Zahnbein ist nach der Darstellung von BARBOSA SUEIRO bei verschiedenen Reptilien, z. B. bei Krokodilen, ein normaler Befund. Wenn es bei höheren Tieren und in seltenen Fällen bei Menschen beobachtet wird, so mag vielleicht — bei aller Schwierigkeit, so entfernt stehende Gruppen von Lebewesen miteinander zu vergleichen — eine atavistische Komponente mit im Spiel sein. Wie LE DOUBLE ausführt, wurde das selbstständige Zahnbein wohl erstmals beschrieben von BEVAN (1863), später dann von ROMITI und LACHI (1883), AJUTOLO (1884), GIACOMINI (1885), DWIGHT (1887), LOCKE und TURNER (1890), SERRANO (1895), ferner ein Fall von LE DOUBLE selbst (1912). BARBOSA SUEIRO bringt 1933 eine weitere Beobachtung. Anhand von 11 Fällen befaßt sich MCRAE 1953 mit der Frage der Beweglichkeit des os odontoideum und der hierdurch bedingten neurologischen Symptomatik. SCHULTZ berichtet über einen Fall eines selbstständigen Zahnbeines bei einem Gibbon und dehnt damit unsere Betrachtung auf andere Primaten aus.

Die vorliegende Mitteilung will anhand von zwei genauer untersuchten Fällen Stellung nehmen zu der Untersuchungstechnik, zu der Art der pathologischen Beweglichkeit des Occipito-Cervicalabschnittes und zu differentialdiagnostischen Fragestellungen sowie zu dem Problem der Belastbarkeit der Halswirbelsäule beim Vorhandensein des selbstständigen Zahnbeines.

Bei der Redaktion am 9. Juni 1961 eingegangen.



Abb. 1. Fall 1. Seitenbild der Halswirbelsäule in Ruhehaltung. Os odontoideum gegen die Achse des Dens gering nach ventral verlagert.

Nomenklatur. Im Altertum war dem 1. Halswirbel die Benennung „Epistropheus" („Dreher"), dem 2. Halswirbel die Benennung „Axis" („Achse") zugeordnet. Im Zusammenhang mit der allgemeinen Umformung des Weltbildes im 16. Jahrhundert hat ANDREAS VESAL für den 1. Halswirbel den Namen „Atlas" bevorzugt, und der Name „Epistropheus" ging an den 2. Halswirbel über.

Die Basler (1894) und die Jenaer Nomenklatur (1935) haben die Bezeichnung „Atlas" für den 1. und „Epistropheus" für den 2. Halswirbel beibehalten, bis schließlich die Pariser Nomenklatur (1955) den 1. Halswirbel weiterhin „Atlas", den 2. Halswirbel aber „Axis" nannte. Damit ist zugleich auch eine Übereinstimmung mit der Nomenklatur des angelsächsischen Schrifttums erreicht.

Die vorliegende Betrachtung folgt der Pariser Nomenklatur, so daß also der herkömmliche „dens epistrophei" unter der Bezeichnung „dens axis" erscheint. Das Zahnbein findet man sowohl unter dem Namen os odontoideum wie auch als os odontoides. Wenn auch eine Form, welche zwei griechische Wortstämme mit einer lateinischen Endung versieht, philologisch nicht befriedigt, so wurde doch im folgenden wegen der weiten Verbreitung die Bezeichnung os odontoideum gewählt.

Eigene Fälle

Fall 1. Ein bei der Untersuchung 9jähriger Knabe, am 9. 6. 1951 geboren, wurde von seinen Eltern zur Klinik gebracht, weil er seit rund 12 Monaten in der Turnstunde unter Übelkeit litt, die sich manchmal bis zum Erbrechen gesteigert hatte. Die neurologische Untersuchung ergab eine beginnende Halbseitenparese links mit Sensibilitätsausfällen.

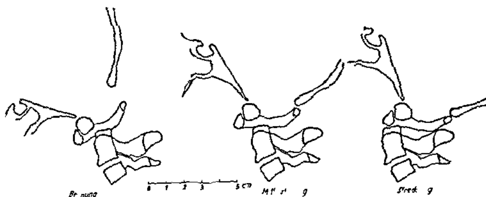


Abb. 2. Derselbe Patient wie in Abb. 1. Skizzen der Verschieblichkeit des os odontoideum mit Atlas und Schädelskelett nach dem Kinofilm angefertigt. Extreme Beugung, Mittelstellung und extreme Streckung der Halswirbelsäule. Seitenprojektion. Der Massstab bezieht sich auf das Skelett.

Röntgenuntersuchung: Es fand sich ein selbstständiges os odontoideum, welches in Ruhehaltung der Halswirbelsäule gegen die Achse des dens axis etwas nach vorne verschoben war (Abb. 1). Wegen der nicht ganz achsenrichtigen Stellung des os odontoideum wurde die Beweglichkeit der Halswirbelsäule in Seitenprojektion kinematographisch erfasst. Nur in einem kleinen Sektor der Mittelstellung der Halswirbelsäule fand sich eine angenähert achsenrichtige Lage des Zahnbeins. Schon bei geringer Beugung und Streckung trat eine sehr deutliche Ventral- bzw. Dorsalverschiebung des Atlas zusammen mit dem Schädelskelett auf, so daß eine grobe Einengung des Spinalkanals zustande kam (Abb. 2).

Zur Frage der Erblichkeit der gezeigten Fehlbildung wurden die Eltern des jungen Patienten röntgenuntersucht. Hierbei ergab sich bei Vater und Mutter kein auffälliger Befund an der Halswirbelsäule. Der Knabe hatte keine Geschwister.

Fall 2: *Ein Jüngling*, am *8. 2. 1946* geboren, wurde 14jährig von seinen Pflegeeltern in die Klinik gebracht. Der junge Patient treibt in der Schule und außerhalb viel Sport. Vor etwa 6 Monaten habe er beim Fußballspiel den Ball mit der Stirn abgefangen und dabei einen plötzlichen stechenden Schmerz am Hinterhaupt verspürt, so daß er das Spiel unterbrechen mußte. Später sei ihm bei ähnlichen Gelegenheiten aufgefallen, daß die Schmerzattacke ausblieb, wenn *er den Ball nicht* mit der Stirn, sondern mit dem Scheitelbein auffing, wenn er also die Halswirbelsäule mehr in Achsenrichtung belastete. Schwindel, Übelkeit, Benommenheit seien auch bei *manchen Arten* des *Bodenturnens* aufgetreten, besonders bei der sogenannten Rolle. Wegen ähnlicher Beschwerden mußte er den Kopfsprung ins Wasser meiden.

Röntgenuntersuchung: Die Übersichtsbilder der Halswirbelsäule zeigten ein verhältnismäßig flaches selbstständiges Zahnbein. Sowohl kinematographisch wie in Schichtbild in der Medianebene (Abb. 3) konnte eine Verschieblichkeit des Atlas *auf der Axis* bei Beugung und Streckung bewiesen werden. Besonders die Beugung führte zu einer deutlichen Einengung des Spinalkanals. Der Patient hatte außerdem eine spina bifida am ersten Brustwirbel.

Zur Frage der Erblichkeit der Mißbildung konnten keine Untersuchungen angestellt werden, weil über lebende Blutsverwandte des Patienten keine Angaben zu erhalten waren.

Bezüglich der Symptomatologie dieser Fehlbildungen bestätigen die beiden gezeigten Fälle das schon von McRae 1953 erwähnte. Nach seinem Bericht kann durch occipito cervicale Veränderungen das Bild der Syringomyelie der



Abb. 3. Fall 2. Medianschichtbilder der Halswirbelsäule bei extremer Beugung und Streckung. Deutlich verschiebliches os odontoideum mit Einengung des Spinalkanals

Syringobulbie, der multiplen Sklerose, der myatrophischen Lateralsklerose und das des hohen Halsmarktumors vorgetäuscht werden. McRae weist auch darauf hin, daß der Beginn der Erscheinungen meistens auf einen verhältnismäßig kleinen Unfall folgt. Bei dem 2. Patienten trafen wir außerdem einzelne Beschwerden, die an eine Neuralgie des nervus occipitalis erinnern. Vielleicht kommt es also auch zu einer lokalen Irritation der austretenden Nervenwurzeln in Höhe der Fehlbildung auf der Basis der abnormen Beweglichkeit.

Nach eigenen Beobachtungen ist die Diagnose des os odontoideum nicht immer so einfach wie in den beiden gezeigten Fällen. Dies wird beim nächsten Fall illustriert.

Fall 3. Der 41jährige Patient hatte in einer auswärtigen Klinik stationär eine Galle-Pankreas-Schonkur mitgemacht. Er wurde im Anschluß daran in die Nervenklinik überwiesen, weil sich eine eigentümliche Muskelschwäche eingestellt hatte. Die Knie waren kraftlos und knickten besonders beim Abwärtssteigen auf der Treppe ein. Beim Bücken konnte sich der Patient nur aufrichten, indem er an den Knien hochkletterte. In der Wadenmuskulatur spürte der Patient ein eigentümliches Ziehen. Bei der Einweisung fehlten die Sehnenreflexe. Das ganze Krankheitsbild entsprach einer *Polyneuritis*.



Abb 4 Fall 3 Schichtbilder der Occipito Cervicalgegend in zwei Ebenen Os odontoideum in Seitenprojektion nur sehr schwer zu erkennen

Röntgenuntersuchung Die Übersichtsbilder der Halswirbelsäule zeigten einen ungewöhnlich stumpfen und kurzen dens axis dessen craniale Kontur den vorderen Abschnitt des Atlasbogens gerade erreichte und nur eine ungewöhnliche Schliff Fläche mit ihm ausgebildet hatte Dabei war der Atlas etwas nach dorsal versetzt Schichtbilder der Occipito-Cervicalgegend in zwei Ebenen wurden angefertigt (Abb 4) Der Befund war zuerst in hohem Grade auf eine sogenannte Dens Aplasie verdächtig aber ein kalkarmes Skelettelement sass dorsal auf dem so deren Abschnitt des Atlasbogens fast ohne Gelenkspalt und zwar an der Stelle wo normalerweise das Atlas Dens Gelenk liegt

Damit verhielt sich also dieses Skelettelement ähnlich wie ein kleiner Wirbelkörper zum Atlasbogen Aus äußeren Gründen konnten keine Untersuchungen zur Beweglichkeit der Occipito-Cervicalregion der Halswirbelsäule gemacht werden

Somit bleibt unklar ob das gefundene os odontoideum symptomlos war oder ob es am Zustandekommen des geschilderten Krankheitsbildes Anteil hatte

Wie hier gezeigt wurde kann die Diagnose des os odontoideum gewisse differential diagnostische Schwierigkeiten zur sogenannten Dens Aplasie bringen STIEFEL ROBERTS SCANNELL haben je über einen WEILER über zwei Fälle unter der Diagnose des congenitalen Densmangels berichtet Alle erwähnten die Instabilität des veränderten Halswirbelsäulenabschnittes Aber nur SCANNELL zeigt Schichtbilder seines Falles Die übrigen Autoren haben — nach den Bildern ihrer Berichte *zu schließen* — ihre Fälle differential diagnostisch gegen ein os odontoideum nicht abgeklärt und es mag sich ein kalkarmes selbstständiges Zahnbein bei manchem „congenitalen Densmangel" verborgen haben BUETTI berichtet über *einen* Fall BROCHER über drei Fälle wo die exakte Untersuchung einer sogenannten Dens Aplasie doch noch ein selbstständiges Zahnbein nachweisen konnte Für *BROCHER* werden daher Begriffe wie Dens Aplasie und os odontoideum zu Synonyma



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Tabelle

	Beuge und Streckfähigkeit			Ventrodorsale Verschieblichkeit des Atlas mm	Sag Durchm des Spinalkanals/mm		Atlas Dens Strecke = normaler sagittaler Durchmesser d. Spinalkanals
	Atlanto-occipital	Atlanto-axial	zusammen		bei Beugung	bei Streckung	
Nach Brocher	0 —31 im Mittel 15 6	6 —23 im Mittel 14 3°					
Nach Mollier cit nach (3 Probanden) Brocher			im Mittel 30				
Eigene Untersuchungen (2 norm Probanden) 37 und 43 Jahre	0 — 1	20 —22	20 —23	<1 mm			16—19 mm
Patient Nr 1 mit os odontoideum 9 Jahre	14	29	43	14 mm	12 7	15	16 mm
Patient Nr 2 mit os odontoideum 14 Jahre	8	32	40	15 mm	9 0	28	19 mm

Von Interesse ist in jedem einschlägigen Fall der Grad der pathologischen Beweglichkeit im occipito cervicalen Abschnitt. Zu dieser Frage wurden bei den Patienten Nr 1 und Nr 2 aufgrund der Kinematographie bzw. der Röntgenschichtbilder Ermittlungen angestellt. Es ergab sich, daß das ventrodorsale Gleiten des Atlas auf der Axis gar nicht die einzige abnorme Bewegungskomponente ist. Bei beiden Fällen war auch eine ungewöhnlich große Beuge- und Streckfähigkeit zwischen dem 1. und 2. Halswirbel zu sehen. Diese Beobachtung legt den Schluß nahe, daß das selbstständige Zahnbein den oberen Abschnitt der Halswirbelsäule allgemein zu einem punctum minoris resistentiae für alle Bewegungskomponenten macht. Naheliegend ist, daß neben den gemessenen Bewegungen auch eine ungewöhnlich große Torsion vorliegt. Diese können wir aber zahlenmäßig nicht belegen. Die Tabelle bringt eine Zusammenstellung der Bewegungsexkursionen, wie sie von Brocher und Bakke und Mollier (nach Brocher citiert) bei Normalen gefunden wurden. Ferner sind die entsprechenden Werte für zwei halswirbelsäulengesunde Patienten und für die beiden Patienten mit selbstständigem Zahnbein aufgenommen.

Wie die Tabelle zeigt, treten schon beim Normalen sehr große Unterschiede in der Beuge- und Streckfähigkeit zwischen Atlas und Axis und zwischen Atlas und Occiput auf. Gerade die Fälle mit geringer Beuge- und Streckfähig



Abb 5 Seitenbild der Halswirbelsaule bei einem 11 Monate alten Knaben Physiologische Spalte im Gebiete der späteren Synostose zwischen dem 2 Halswirbelkorper und dem Dens Axis

keit im Atlanto-Occipitalgelenk uberraschen, weil seiner Morphologie nach dieses Gelenk rein funktionell fur Beuge und Streckbewegungen sehr gut geeignet erscheint Besonders eindrucksvoll ist die abnorme Gleitfahigkeit des Atlas auf der Axis in ventro dorsaler Richtung und die sich daraus ergebende E[illegible]gung des Spinalkanals im sagittalen Durchmesser bei den selbststandigen Zahnbeinen

Zur Entstehung des selbststandigen os odontoideum Entwicklungsgeschichtlich ist die Entstehung des selbststandigen Zahnbeines nicht ganz einfach zu erklaren Zunachst ist bekannt daß sich im Korper des zweiten Halswirbels ein Knochenkern und im Zahnfortsatz ein paariger Knochenkern bilden die im Verlaufe der weiteren Entwicklung miteinander verschmelzen (Geipel) Brocher und andere nehmen an daß im Falle der Selbststandigkeit des Zahnbeines diese Verschmelzung der Knochenkerne ausbleibt Die Stelle der physiologischen Synostose dieser Kerne liegt aber viel weiter caudal als die Fuge zwischen dem Dens und dem selbststandigen os odontoideum Das normale Verhalten zeigt ein Seitenbild der Halswirbelsaule bei einem 11 Monate alten Knaben (Abb 5) Die physiologische Synostose zwischen den Knochenkernen des Dens und dem des zweiten Halswirbels entspricht ihrer Lage nach nicht dem Spalt zwischen dem Dens und dem selbststandigen Zahnbein So sieht man z B auch auf Abb 1 die Stelle dieser physiologischen Synostose noch und zwar ganz unabhangig von dem vorhandenen os odontoideum Schon Le Double weist ubrigens darauf hin daß sich die physiologische Synostose häufig als querverlaufende Rinne an typischer Stelle erhalt Sie ist manchmal sogar im Rontgenbild manifest



Abb. 6. Vorderbild einer Halswirbelsäule bei einem Mann. Persistenz der in der Kindheit physiologischen Fuge zwischen dem Körper des 2. Halswirbels und dem Zahnfortsatz. (Das Bild verdanken wir Herrn Professor OESER.)

Eine Unterbrechung der knöchernen Kontinuität tief im 2. Halswirbel ist in Abb. 6 gezeigt. Die Stelle entspricht der physiologischen Fuge zwischen dem Körper des 2. Halswirbels und dem Dens. Im vorliegenden Fall ist offenbar in der Entwicklung der Schluß dieser Epiphyse ausgeblieben. Einer funktionellen Belastung war diese persistierende Epiphyse nicht ausgesetzt, weil Atlas und Axis eine dorsale Synostose hatten, die in der vorhandenen a. p. Projektion nicht zu erkennen ist.

Das selbstständige Zahnbein wurde schon auf alte Frakturen, vielleicht früh kindlich erworben, zurückgeführt. Dieser Meinung ist entgegenzuhalten, daß der Röntgenbefund des typischen os odontoideum rein morphologisch niemals einem alten Bruch oder einer Pseudarthrose entspricht. ALBRECHT zeigt an Hand embryologischer Studien, wie sich die Spitze des Dens nicht vom Körper des 1. Halswirbels, sondern von einem Occipitalwirbel herleitet. Es liegt also der Schluß nahe, daß im Falle des selbstständigen Zahnbeins die physiologische Vereinigung zwischen dem Körper des 1. Halswirbels und der aus dem Occipitalwirbel entstehenden Densspitze ausgeblieben ist. Auffällig bleibt aber, daß die caudale Fläche des os odontoideum zumeist ganz gerade ist, während die Knochenanlage der Densspitze normalerweise zapfenförmig zwischen die beiden Knochenanlagen des dens axis hineingreift. Ob im Falle des os odontoideum eine untypische Verknöcherung des Dens, also ein unpaarer Knochenkern, vorliegt, muß zunächst völlig offenbleiben.

Man findet nun ossa odontoidea sehr verschiedener Größe. Dies berechtigt zu dem Schluß, daß auch eine cranio-caudale Anlageverschiebung eine Rolle spielen kann. Für solche Wirbelverschiebungen — allerdings an anderen Stellen der Wirbelsäule — hat KÜHNE ein dominant recessives Genpaar nachweisen können. Manchmal ist die caudale Fläche des Occipitalwirbels, welche

sich normalerweise in die beiden Hinterhaupts Condylen differenziert noch an der ventralen Begrenzung des Hinterhaupts vorhanden Sie kann dann mit der Spitze des dens axis artikulieren Vielleicht ist bei einer solchen mangel haften Differenzierung eine Anlageverschiebung mit im Spiel MECKEL hat anhand eines solchen Falles am Anfang des 19 Jahrhunderts die Diskussion uber den Occipitalwirbel in das medizinische Schrifttum gebracht Atlas Assimilationen wie sie beim Menschen z B BARBOSA SUEIRO und bei anderen Primaten SCHULTZ beschrieben haben sind ebenso als Anlageverschiebungen aufzufassen

Über die Erblichkeit des selbststandigen Zahnbeins war in der Literatur keine Angabe zu finden Eigene Untersuchungen zu dieser Frage lassen zwar keine endgultige Aussage zu jedenfalls scheint kein dominantes Gen fur die Ausbildung des selbststandigen os odontoideum verantwortlich zu sein

Klinische Schlußfolgerungen

Das angeborene selbststandige Zahnbein muß manchmal gegen alte Frakturen des dens axis abgegrenzt werden Ebenso hat bei der connatalen Atiologie der Zusammenhang einer pathologischen Beweglichkeit des occipitocervicalen Abschnittes mit klinischen Erscheinungen eine Bedeutung

Fur die Untersuchungstechnik ergibt sich die Notwendigkeit alle Falle von klinischem Verdacht auf Syringomyelie multipler Sklerose, hohem Halsmark tumor myotrophischer Lateralsklerose auf occipito cervicale Übergangsmißbildungen zu untersuchen Im Falle einer Mißbildung ist die Schichtaufnahme der Occipito Cervicalgegend in zwei Ebenen unerlaßlich Zur Feststellung einer pathologischen Beweglichkeit sollen Seitenbilder bei extremer Beugung und Streckung eventuell auch Schichtbilder der Median Ebene oder eine Kinematographie des Bewegungsvorganges angefertigt werden

Als vorbeugende Maßnahme zur Vermeidung von klinischen Komplikationen sollten alle Beschaftigungen und Sportarten vermieden werden die eine besondere Belastung der Halswirbelsaule bedingen Inwieweit auch von Sportarten abzuraten ist die ein erhohtes Sturzrisiko mit sich bringen wie Mannschaftssport Ski Sport usw ist im einzelnen Fall zu entscheiden

ZUSAMMENFASSUNG

Anhand von zwei Fallen mit selbststandigem os odontoideum wird eine abnorme Beweglichkeit des occipito-cervicalen Übergangsabschnittes gezeigt und besonders auf die Einengung des Spinalkanals mit der Moglichkeit einer neurologischen Symptomatik hingewiesen Die Arbeit kommt zu Folgerungen fur die rontgenologische Untersuchungstechnik und fur die Vermeidung klinischer Storungen

SUMMARY

Abnormal mobility at the occipito-cervical junction caused by separation of the odontoid process is described with particular reference to compression of the spinal canal with the possible production of neurologic signs Two cases are presented The roentgenologic examination is considered and attention drawn to the prevention of clinical disturbances

RÉSUMÉ

Les auteurs décrivent la mobilité anormale au niveau de la jonction occipito-cervicale due à la séparation de l apophyse odontoide et étudient particulièrement la compression du canal rachidien pouvant donner des signes neurologiques Ils en présentent deux cas Ils décrivent l examen radiologique et attirent l attention sur la prévention de troubles cliniques

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Preliminary communications from

COLLEGIUM ORBIS RADIOLOGIAE DOCENTIUM (C O R D)

Communication 1

At the Meeting in Zurich, Switzerland, on October 13th to 15th, 1961, the above name has been given to the association formerly called the "World Association of University Professors of Medical Radiology"

The Executive Committee was elected as follows SCHINZ (Switzerland), President, TURANO (Italy), Vice President, LEDOUX LEBARD (France), Treasurer, COCCHI (Zurich), Secretary, BECKER (Germany), PEIRCE (Canada), and ZIEDSES DES PLANTES (Netherlands), Members at large

Communication 2

Re *Item for Discussion No 8 Operation of radiation protection in hospitals*

It was decided that

1 As the operation of radiation protection in hospitals presupposes a comprehensive specialist knowledge in radio diagnosis and radio therapy as well as in radiobiology physics and applied sciences its responsible direction must be in the hands of the senior doctor for medical radiology working in the hospital

2 The senior doctor for medical radiology must see that the regulations governing protection *against radiation laid down by law as well as internationally recognised* rules are observed for the protection of patients and hospital staff

3 Should there be no radiologist specialist at the hospital protection against radiation should be entrusted to a radiologist specialist from outside

4 Every country is recommended to form a committee comprising medical radiologists and biophysicists Such a committee will control whether the medical measures as a protection against radiation are in accord with the law and internationally accepted norms This is recommended for countries where such committees do not already exist

Communication 3

Re *Item for Discussion No 10 Creation of European Centre for Radiobiology and Radiotherapy (Radiation Hospital)*

After preliminary detailed discussion most members welcomed the creation of a European Centre for Radiobiology and Nuclear Medicine while rejecting the establishment of a European Radiation Hospital The national associations for medical radiology and nuclear medicine in Europe are requested to appoint one delegate each to form a preparatory committee The plan will be put before the Tenth International Congress of Radiology in Montreal, Canada

Notifications to Prof H R Schinz Kantonsspital Zurich Switzerland

Communication 4

Re *Item for Discussion No 1 Medical radiology as compulsory subject of study and examination subject*

The overwhelming majority of delegates at the Zurich meeting thought that medical radiology was primarily a clinical subject Medical students should attend the lectures and

courses *on a compulsory basis* and sit for an *examination* which should be under the full professor (ordinarius) of m dical radiology — who should be a doctor — as part of their medical finals

Only a small number of delegates were against an examination

Communication 5

Re *Item for Discussion No 4 Separation of the chair for medical radiology into a professorship of roentgen diagnosis and a second one of radiotherapy*

Most delegates at the Zurich meeting spoke *against* a division of the professorial chair for medical radiology in student teaching at the schools of medicine believing it best to preserve th unité de doctrine during the years of medical study Teaching should be given by a professor in medical radiology who is himself a doctor He should have at his disposal in the university infirmary a central institute of roentgen diagnostics and a central radiation clinic For the training of specialists (full radiology and part radiology) as well as at centres that are purely concerned with research a differentiation into biophysics a tinic biology and clin cal radiology is possible whereby the instruction can be divided between various teachers In big hospitals it may be possible to separate the central institute for roentgen diagnosis from the central radiotherapy clinic

Communication 6

Re *Item for Discussion No 5 International division of stages of malignant tumors*

The *TNM System* the *TM System* the *T System* and the *M System* of the division of tumor stages is again presented to the Zurich working conference for discussion There is an unanimous conviction about the necessity of an internationally uniform division of stages for purposes of comparing the results of various methods of cancer treatment and of the same methods of cancer treatment in different places Members of the conference would like to have a meeting of the I C P R with the appropriate commission of U I C C (Union internationale contre le Cancer) in order to remove differences of a secondary order in framing the universal classification system The national radiologists associations were authorised by *conference* to make an exact textal revision of the terminology of the stages of disease for all tumor localisations The survey of the primary tumor and of the metastasis conditions was made in the mentioned systems by clinical means A surgical or pathological anatomical definition of the stage of the disease would be more exact The Collegium Orbis Radiologiae Docentium have come out in favour of retaining all three possibilities provided the method of making the findings is stated expl citly in defining the stage

Communication 7

With *Reference to Subject of Discussion 11 Organisation of assistants exchange between countries*

The delegates spoke with a united voice of the need for an exchange of medical assistants between the various univers ty X ray institutes at home and abroad A stay of six months was regarded as an absolute minimum whereby salaries would continue to be paid in full

No decision was reached as to an exchange agency In the USA there exists a Committee of the International Exchange of Persons

From one quarter came the suggestion that the Secretariat of C.O R D should organize the exchange Another idea was that it should be done through the International Society of Radiology

You are asked to reply with your comments on the idea of an agency

Communication 8

Re *Item for Discussion No 2 Introduction of post graduate courses at university radiation institutes*

Most participants at the Zurich meeting considered the establishment of post graduate courses as something very desirable and necessary Such courses can be held at university institutes as well as at the larger hospitals with central X ray institutes and radiotherapeutic clinics We should differentiate between fully occupied radiologists and specialists in other branches of medicine who engage in medical radiology in addition to their main subject It was generally thought that such a specialist training should be rounded off with an examination similar to that held in USA whereby the examining board may well be composed of specialist doctors from medical radiology even if they are not appointed as lecturers at the universities

Communication 9

Re *Item for Discussion No 12 The question of splitting the international congresses of radiology*

The written statement from R Paterson Manchester was sent to all participants prior to the Zurich meeting In the discussion most of the meeting expressed themselves against splitting up whereby it was obvious that the decision cannot be made by C O R D but by the Tenth International Congress of Radiology in Montreal 1962 The question of a three four or five year rotation was left open On the other hand approval was given to the suggestion of Sarasin Geneva that the existing Congrès de Radiologie Médicale de la Langue Latine should be extended to become an Inter European Congress of Radiology — along the lines of the Inter American Congress of Radiology — which should alternate with the International Congress of Radiology The organisers of the existing Congrès de Radiologie Médicale de la Langue Latine were asked to give close study to this problem

Communication 10

Re *Item for Discussion No 6 Change over in the radiotherapeutic clinics and institutes to megavolt therapy*

All participants at the Zurich meeting agree that megavolt therapy must be operated on an ever increasing scale whereby it will gradually almost completely oust conventional therapy In some clinics up to 60 per cent of the radiation treatment is now being made with megavolt rays In cases where there are facilities for betatron radiation this method is to be preferred to cobalt radiation since it makes electron therapy possible

New vistas are opened up by electron therapy If possible electron therapy should be free from dispersal electrons and the energy must be adjusted to at least 40 MeV The costs of betatron radiation would become less as soon as the apparatus became cheaper

Communication 11

Re *Item for Discussion No 7 Measurements in roentgen (r) in rho (ρ) and in millicurie (mC) as well as dosage in rad*

It was brought out in discussion that there was a vital need for the units of measure to be elucidated further The proposal of a division into radiometry and dosimetry is a new contribution towards clarification The Zurich motion further proposes to measure as auxiliary size of ionisation in rho (ρ) in the case of dosimetry by application of the Bragg Gray principle independently of the radiation quality The roentgen (r) will remain the unit of measure for radiometry, whereby measurements should be taken under equilibrium of electrons In the case of radiometry we cannot speak of dosages but only of test values in roentgen (r)

In dosimetry we have to deal with dosages as understood in medical pharmacology the internationally accepted unit of dosage being the rad which can be easily converted from the rho These proposals were placed on record and referred to ICRU for further deliberation

Communication 12

Re *Item 3 The centralisation of isotopic diagnosis and therapy*

The majority of participants at the congress in Zurich expressed the opinion that isotopic diagnosis and therapy belonged first and foremost in the hands of the teacher of medical radiology and that these examinations should be conducted by him A division of this field among separate clinics should not be countenanced In this way a contamination of the hospital by radio-isotopes would be counteracted Research in this field is however unrestricted In any particular question the radiologist should be prepared to place both his experience and his instruments at the disposal of both the theoretician and the specialist

Communication 13

Re *Item 9 The position of the physicist in the hospital*

Both the attendant specialists for medical radiology and the biophysicists were agreed that whereas biophysics and radiation biology were indeed auxiliaries of medical radiology the entire responsibility towards patients and hospital staff rests on the shoulders of the medical radiologist as indeed it should do The physicist was to render the medical specialist assistance in the planning and execution of a radiation therapy and in the delivery of radio-isotopes But he should not want to act the doctor as well He is prohibited from administering medicines or injections He can be of great value in the carrying out and control of the regulations for the protection against radiation in X ray institutes radio-therapeutic clinics and hospitals The doctor will be grateful for his co operation in the fields of active practice instruction and research

Final

The majority decisions and opinions of the participants at the Congress held between 13—15 October 1961 in Zurich were briefly summarized in a number of telegrammatic communiqués to the specialist press Due to lack of time it was impossible to deal with the 13th item The Distribution of the Fees of Private Patients between Hospital and Physician Chief All replies received and contributions to the discussions together with all other arguments will be published in full The publication has been guaranteed by the Editor of Radio Therapy (Prof J Becker) It would be appreciated if the airing of imminent differences of opinion could be postponed until after the appearance of this publication For the present however I wish to thank all participants

H R Schinz
President

BOOK REVIEW

ANGIOGRAPHY. Vols I and II. Edited by Herbert L. Abrams. 807 pages and 1 345 illustrations. Little Brown & Co. Boston 1961. Price $ 47.50.

Current knowledge of the vascular system in man is presented in this two-volume work. Thirty two contributors representing many schools and several nations ensure a more authoritative treatment of each of the various parts of the subject than would otherwise have been possible.

The editor who contributes to the introductory section has also written some of the chapters in the thoracic aortography section. General Considerations include historical notes and information on opaque media and are of great value. The chapters on cerebral angiography are comprehensive and instructive and contain excellent illustrations and explanatory anatomical diagrams. Thoracic aortography both in the child and adult is treated in detail by several authors. Coronary arteriography and pulmonary arteriography as well as examinations of the great venous systems of the thorax and abdomen are dealt with in sections which are profusely illustrated.

Volume II deals with the abdomen, pelvis, and extremities. The treatise on renal angiography is prefaced by a consideration of the anatomy and physiology. Adrenal and pancreatic angiography and hepatic arteriography are subjects of different and well illustrated sections. Splenoportal venography forms an informative and lucid chapter, and the same may be said of the one devoted to uterine arteriography. Arteriography of the upper and lower extremities is considered at length but venography of the lower extremities appears to have been given a rather short survey. Angiography of bone and lymphangiography are treated in the final chapters of the volume. It is possible that some kind of contrast levelling might have produced better detail in some of the films of the extremities, many of which are too contrasty. On the other hand, this appears to have been slightly overdone in some of the illustrations of aneurysms of the thoracic aorta.

The books are beautifully printed and there are a total of about 1 500 references. The general impression of solid quality is gained and the present reviewer would like to agree with Henry S. Kaplan in his foreword when he congratulates the editor, the internationally renowned contributors, and the publisher, on the fine team work that has produced this result.

Ole Mattsson

ACTA RADIOLOGICA

OFFICIAL ORGAN OF THE RADIOLOGIC SOCIETIES OF
DENMARK FINLAND NORWAY AND SWEDEN

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MILD PULMONARY VALVULAR STENOSIS STUDIED FUNCTIONALLY AND ANATOMICALLY

by

ULF RUDHE JOSEPH E WHITLEY and HARRY HERZENBERG

Mild pulmonary valvular stenosis with an intact ventricular septum (also termed isolated solitary and with normal aortic root) has received little attention in the roentgenologic literature (KJELLBERG et coll 1955 1959, and GAY & FRANCH 1960) We have had twenty cases in which the diagnosis has been established by cardiac catheterization in sixteen of these selective angiocardiography was also performed Five of these cases were previously reported by KJELLBERG et coll For purposes of this investigation mild solitary pulmonary stenosis was defined as valvular stenosis by which at catheterization a peak right ventricular pressure no greater than 50 mm Hg with the patient at rest was demonstrated and no evidence of a left to right shunt by oximetry

Methods and Material The initial clinical impressions conventional roentgenograms cardiac catheterization data and selective angiocardiograms were studied in these 20 cases and contrasted with 15 normal cases and 19 verified cases of moderate and marked stenosis The normal cases consisted of 9 cases

From the Roentgendiagnostic (Director Docent U Rudhe) and Pediatric Departments of the Children's Clinic Karolinska Sjukhuset Stockholm Sweden Submitted for publication 8 December 1961



Fig. 1. A 14 year old male with all the classic features of mild solitary pulmonary valvular stenosis. The right ventricular pressures were 15/0 mm Hg as compared to 10/2 mm Hg in the pulmonary artery. Note the size of the left main pulmonary artery as seen in the left anterior oblique projection.

investigated for murmurs that were considered 'functional' after clinical examination, including right heart catheterization and angiocardiography, and 9 cases of coarctation of the aorta in which the size of the heart and the right heart catheterization findings were normal. The mean age of the mild pulmonary stenosis group was 9.4 years with a range of 20 months to 15 years. There were 9 females and 11 males.

Conventional roentgenography consisted of fluoroscopy and frontal, lateral, and oblique projections of the chest during a barium swallow. The details of the techniques of cardiac catheterization and angiocardiography employed in this series are described elsewhere (KJELLBERG et coll.). The selective angiocardiograms were obtained while the contrast medium was being injected into the right ventricle with simultaneous filming with an Elema serial changer at a rate of 6 or 12 frames per second in the frontal and lateral projections, the moment of each exposure was indicated on an electrocardiogram that was recorded concurrently.

Results

In the conventional roentgenographic examinations it was demonstrated that the atrial and ventricular configurations and the heart size were normal in the mild group. The heart volume averaged 298 cc/m² body surface area with a range of 240 to 390 cc/m². There was at least slight dilatation of the main pulmonary artery present in all but one (in which case the subject was 20 months old) of the cases of mild pulmonary stenosis. In 11 cases the pulmonary



Fig 2 Selective angiocardiography in a 10-year old female a) A-P view of the pulmonary orifice early during the injection b) Frontal and c) lateral view both obtained later during the injection Typical dome shaped appearance of the fused cusps in systole and post stenotic dilatation of the main left and right pulmonary arteries Right ventricular pressures 45/5 versus 11/1 mm Hg in the pulmonary artery

artery was judged to be moderately or markedly dilated The left main pulmonary artery was considered slightly enlarged in 4 and moderately or markedly so in 7 cases This enlargement of the left pulmonary artery was best seen in the left anterior oblique projection (Fig 1) The right pulmonary artery and the peripheral pulmonary vasculature were thought to be normal throughout



Fig 3 Lateral projection from angiocardiography in a 2 year old male with right ventricular pressure of 42/8 and pulmonary artery pressure of 14/7 mm Hg Atypical thickness of fused valve cusps

Cardiac catheterization demonstrated a mean of the peak right ventricular pressures of 39 2 mm Hg with a range of 32 to 47 mm Hg The range of peak systolic gradients between the right ventricle and the pulmonary artery was 13 to 35 mm Hg with a mean of 24 mm Hg These pressures were recorded in the resting state A few patients were exercised and then uniformly had an increase in the right ventricular pressure and valve gradient

Selective angiocardiography revealed normal right ventricles and infundibuli throughout the mildly stenotic series In every case the dome shaped appearance of the fused cusps was identified during systole (Fig 2) The cusps were thin and flexible in all but one case (Fig 3) Where possible, both the anterior posterior and lateral dimensions of the pulmonary valve opening were estimated by measurement of the jet and orifice, or either, and, after correction for magnification, the average dimension was calculated as a diameter to obtain the area of a circle The orifice areas thus estimated in the cases of pulmonary stenosis and the normal cases were plotted and are superimposed on the normal values, as given by HURWITT (1947), in Fig 4 A comparison of the orifice area of each individual in the mild group with the average normal area for individuals of the same age demonstrated a mean reduction

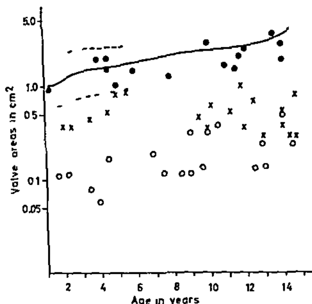


Fig 4 The pulmonary valve areas estimated by angiocardiography in the normal cases and the solitary pulmonary valvular stenosis series represented on a semi logarithmic scale Normal means and the range of two standard deviations (-----) are superimposed after HURWITT (1947) Normal cases are indicated by ● mild pulmonary stenosis by × and moderate and marked pulmonary stenosis by o

in valve area of 29 % of the predicted normal size with a range of from 9 to 50 % For the moderate group (with peak right ventricular pressures from 70 to 100 mm Hg) such a comparison revealed an average reduction of 13 5 % of the predicted area with a range of from 9 to 15 % In cases with a peak right ventricular pressure of over 100 mm Hg the mean reduction was down to 7 7 % (range 4 to 13 %)

The size of the pulmonary annulus as seen angiocardiographically was estimated from the width of the right ventricular outflow tract at the lower margin of the insertion of the pulmonary valve cusps and was normal in the mild group as compared with the normal and those reported by DE LA CRUZ (1960) The width of the pulmonary annulus during systole and diastole divided by the width of the aortic annulus yielded a ratio of 1 0 or more in the normal and mildly stenotic cases in contrast to the more markedly stenotic cases in which consistently lower ratios were found (Fig 5)

The maximum diameter of the trunk of the main pulmonary artery was measured from the angiocardiograms in the two views corrected for magnification, and averaged Nineteen of the mild cases were larger than in the

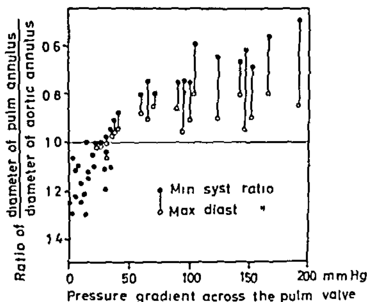
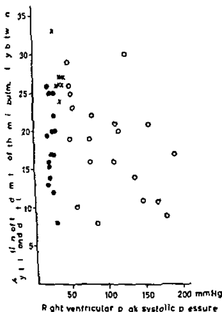


Fig 5 Normal cases and the cases of solitary pulmonary stenosis in systole and diastole

comparable normal cases in the series and the normal values given for individuals of the same age in the literature (DE LA CRUZ et coll, 1960, and HURWITT 1947) The one exception was the youngest case In 16 of the 19 moderate and severe cases a similar enlargement was demonstrated, and one of the 3 exceptions was 2 years of age The differences were more marked in systole than in diastole In general the dilatation of the pulmonary artery tended to be more marked in cases with mild pulmonary stenosis than in those with severe stenosis of the same age group as has been previously suggested (AYRES & LUCAS 1960, and POWELL 1959) There were certain outstanding exceptions which make this maxim of no value in assessing the degree of severity in the individual case

The amplitude of intrinsic pulsation was calculated as the change in the diameter of the main pulmonary artery between systole and diastole (Fig 6) and was usually more marked with mild pulmonary stenosis than in the normal group, as has been observed by GAY et coll (1960) The average percentage change in the diameter during the cardiac cycle for the mildly stenotic group was 25 5 % against 18 8 % for the normal cases In the severe stenotic group the relative amplitude of intrinsic pulsation was extremely variable, but the mean percentage change was not different from the normal group In the severe group the heart rate was plotted against the relative pulsatory amplitudes and was not found to be a definite factor influencing this wide variation The relative type of comparison disguises some large absolute variations in grossly dilated pulmonary arteries in the mild and

groups



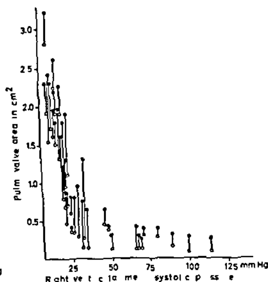


Fig 6 The amplitude of intrinsic pulsation in the main pulmonary a tery expressed as a per ce tage va iation in ts d ameter during the card ac cycle n the normal cases and the sol tary pulmonary tenosis series Normal cases are indicated by ● m ld pulmonary stenosis by × and moderate and severe pulmonary stenosis by

F g 7 A comparison of the pulmonary valve areas calculated from the catheterizat on data by the hydrodynamic formula with those est mated by selective ang ocard ography in the same cases
Calculated hydrodynamically
Estimated angiocardiographically

The predicted valve area was calculated from the catheterization data ac cording to the hydrodynamic formula of GORLIN & GORLIN (1951) The oxygen consumption was estimated from the height and weight according to the nomogram of KARLBERG & IGGBOM The estimated oxygen consumption and the measured arterio venous oxygen difference were used to calculate the cardiac output In the mild group no A—V difference greater than 5 2 vol % was encountered (mean 3 9 vol %) and in no case did the cardiac output fall below 2 5 l/m² (BROTMACHER & FLEMING 1957) The cardiac output was presumed to be equal to the pulmonary flow The mean systolic pressures were obtained from the peak systolic pressures employing a graph that ap peared in an article by CAMPBELL (1960) for the normal and mild cases The electrical means were used in the moderate and severe cases The resulting pulmonary valve areas compared with the areas estimated by angiocardio graphy are seen in Fig 7 An almost uniform difference between the two areas was found those estimated by the angiocardiographic technique being smaller than those calculated by the hydrodynamic formula

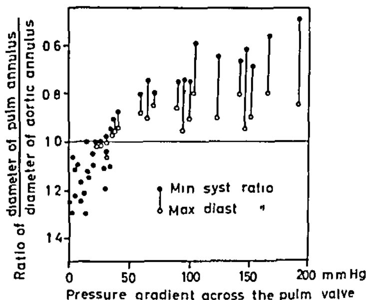


Fig. 5. Normal cases and the cases of solitary pulmonary stenosis in systole and diastole.

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The pulmonary infundibulum and annulus were not found by angiocardiography to be obstructive factors in the cases of mild pulmonary valvular stenosis examined The consistent narrow pulmonary annulus observed in the severe cases raised the question as to whether this deformity is an original part of the anomaly or is an acquired component The writers consider hypertrophy of the musculature of the right ventricular outflow tract to be one important causative factor That this musculature can effect the diameter of the annulus is undeniable for in a normal case the ring is significantly diminished in size with a massive premature ventricular contraction In cases with marked pulmonary valvular stenosis even with a normal rhythm the narrowing previously mentioned is seen to be markedly accentuated during late systole and during the isometric relaxation phase A one to two millimeter variation in the diameter of the pulmonary annulus may also be evident during normal rhythm in some normal and mildly stenotic cases

Whether outflow tract hypertrophy is the sole factor in producing the narrow pulmonary annulus in solitary pulmonary valvular stenosis is uncertain Isolated cases from this small group have been observed in which control angiocardiography several years after successful valvulotomy revealed an increase in the pulmorary annulus/aortic annulus ratio without any surgical procedure having been performed on the annulus BROCK (1961) has described a case in which a presumably rigid pulmonary ring has presented a more formidable obstruction than the accompanying valvular stenosis Cases in which a diminutive pulmonary annulus has played a more prominent obstructive role in the deformity of solitary pulmonary valvular stenosis than those presented in this series have been encountered at this institution however such annuli have varied in size with the cardiac cycle

Selective angiocardiography is useful in obstructive disorders of the outflow tract of the right ventricle principally to outline the anatomy of the obstructing lesion and in severe cases to rule out the presence of a right to left shunt at the ventricular level The technique is not proposed as the method of choice in evaluating the severity of pulmonary valvular stenosis but it may be observed that this task can with fair accuracy be accomplished by the use of the method

The reason for the overlap between the angiocardiographically estimated valve areas in the groups of mild and more severe solitary pulmonary valvular stenosis is not apparent The explanation probably lies in the inability of the method to achieve the accuracy needed in obtaining the measurements used in calculating the valve areas Difficulties were often encountered in estimating the size of the pulmonary orifice if a well defined jet was not obtained This problem was due to the lack of definition of the margins of the leaflets particularly in the normal and mild cases of stenosis both due to the thinness of the cusps and their position in relation to the true frontal and lateral projections This problem together with the oversimplification of the shape of

Discussion

The roentgenologic features of mild solitary pulmonary valvular stenosis have been previously described (ABRAHAMS & WOOD 1951, KRIEFF 1954, CLUZET 1956, KJELLBERG et coll. 1955, 1959, FABRICIUS 1959, and GAY & FRANCH 1960). The incidence of the finding of dilatation of the left as well as the main pulmonary artery has perhaps been under emphasized since it occurred in the majority of cases in this series. It is apparent from angiocardiography that the right main pulmonary artery is dilated almost as frequently as the left, however the course of this vessel precludes its recognition in conventional roentgenography.

With conventional roentgenography alone, the differentiation of the dilatation of the main pulmonary artery in pulmonary stenosis, from the prominent pulmonary artery, which is a common normal variant in childhood, may be difficult. During infancy, dilatation of the pulmonary trunk is usually not in evidence in pulmonary stenosis. The roentgenologist's experience in estimating the true dimensions of the artery and in evaluating the amplitude of intrinsic pulsation is important, however in some cases a careful integration of the roentgenologic and clinical data, particularly the auscultatory findings, will be necessary. Differentiation by conventional roentgenology of the mild from the severe pulmonary stenosis is probably best accomplished through critical evaluation of the configuration of the heart chambers, particularly the right atrium, and by estimation of the cardiac volume. The differentiation of idiopathic pulmonary artery dilatation from mild pulmonary stenosis undoubtedly requires special examinations (VAN BUCHEM 1956). Conventional roentgenography alone will readily separate pulmonary stenosis from the most frequent misdiagnosis recorded at the initial clinical study in this series, which was that of a small interatrial septal defect.

It is well known that a peak systolic gradient of up to 10 mm Hg can exist between the right ventricle and the pulmonary artery at cardiac catheterization with no gross anatomic abnormality. The presence of a left to right shunt further complicates the interpretation of pulmonary valve gradients, and angiocardiography is then often needed to demonstrate the anatomy of the right ventricular outflow tract and the pulmonary orifice.

From the data presented, a reduction in the area of the pulmonary valve opening, to a value in the range of 29 % of normal size, is necessary to create a significant gradient and mild right ventricular hypertension with solitary stenosis. It is interesting to note how close this figure is to the 31 % estimated by CAMPBELL using the Gorlin formula as the critical remaining pulmonary valve area in causing mild right ventricular hypertension secondary to solitary stenosis. This figure is also close to the 25 % estimated to be the remaining area of the aorta necessary to create a significant gradient in coarctation by GUPTA & WIGGERS (1951) and IKKOS et coll. (1960).

The pulmonary infundibulum and annulus were not found by angiocardiography to be obstructive factors in the cases of mild pulmonary valvular stenosis examined. The consistent narrow pulmonary annulus observed in the severe cases raised the question as to whether this deformity is an original part of the anomaly or is an acquired component. The writers consider hypertrophy of the musculature of the right ventricular outflow tract to be one important causative factor. That this musculature can effect the diameter of the annulus is undeniable, for in a normal case the ring is significantly diminished in size with a massive premature ventricular contraction. In cases with marked pulmonary valvular stenosis even with a normal rhythm the narrowing previously mentioned is seen to be markedly accentuated during late systole and during the isometric relaxation phase. A one to two millimeter variation in the diameter of the pulmonary annulus may also be evident during normal rhythm in some normal and mildly stenotic cases.

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From the data presented, a reduction in the area of the pulmonary valve opening, to a value in the range of 29 % of normal size, is necessary to create a significant gr*adient and mild right ventricular hypertension* with *solitary* stenosis It is interesting to note how close this figure is to the 31 % estimated by CAMPBELL using the Gorlin formula as the critical remaining pulmonary valve area in causing mild right *ventricular hypertension secondary* to solitary *stenosis* This figure is also close to the 25 % estimated to be the remaining area of the aorta necessary to create a significant gradient in coarctation by GUPTA & WIGGERS (1951) and IKKOS et coll (1960)

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the pulmonary orifice by calculating it as a circular opening, may partly account for the overlap in the areas previously discussed and contribute to the discrepancies between the hydrodynamic and angiocardiographic estimations of valve size The fact that the estimate of oxygen consumption from the body surface area was only approximate may also have contributed

SUMMARY

The angiographic appearances of mild pulmonary valvular stenosis with an intact ventricular septum are described and contrasted with those evident in normal and more severe cases The estimation of the pulmonary valve orifice from the selective angiocardiography is compared to that obtained by the hydrodynamic method The concept of the pulmonary annulus as an additional obstructive component associated with marked pulmonary stenosis is advanced

ZUSAMMENFASSUNG

Das angiographische Aussehen einer leichten Pulmonalklappenstenose mit intaktem Ventrikelseptum wird beschrieben und den Bildern von Normalfällen sowie schwereren Fällen gegenübergestellt Die Beurteilung des Pulmonalklappenorificiums bei der selektiven Angiokardiographie wird mit den Resultaten bei der hydrodynamischen Methode verglichen Die Auffassung dass der Annulus pulmonalis eine zusätzliche obstruktive Komponente ist die mit bedeutenden Pulmonalstenosen verbunden ist wird betont

RÉSUMÉ

Une description angiocardiographique d une sténose pulmonaire valvulaire légère avec septum ventriculaire intact est donnée et son anatomie est comparée avec la normale et avec celle des cas plus graves L évaluation de la grandeur de l orifice pulmonaire à l aide de l angiocardiographie sélective est comparée avec la méthode hydrodynamique L hypothèse est avancée que l anneau pulmonaire pourrait constituer un facteur obstructif additionnel dans la sténose pulmonaire grave

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Fig 1 Case 1 Papillary transition l cell carcinoma of lower part of right ureter a) Ureterography Deformation of ureter at the lower margin of sacro-iliac joint b) and c) Angiography Wide arteries arising from internal iliac artery and supplying a well-defined tumor in which contrast medium is densely accumulated and small tumor vessels are evident Insert in (c) operative specimen of resected ureter

right renal pelvis and ureter were now dilated due to obstruction of the ureter at the level of the lower margins of the sacro-iliac joints

Ureterography disclosed complete obstruction of the ureter with a concave upper border of the column of contrast medium

Angiography which was performed in order to ascertain whether the obstruction was due to a tumor or stone revealed several wide tortuous vessels branching early from the internal iliac artery and running to a tumor about 3 cm by 3 *cm in size* with small irregular vessels in the arterial phase and a dense accumulation of contrast medium in the capillary phase Since the function of the left kidney was severely impaired by pyelonephritis it was not possible to remove the right kidney and ureter the operation was therefore limited to excision of the tumor with end to-end anastomosis of the ureter

Pathologic examination A papillary transitional cell carcinoma was attached to the wall of the ureter by a fairly narrow stem and was invading the submucosa At control urography the kidney was found to be functioning satisfactorily and the pelvis and ureter were no longer dilated

Case 2 Woman aged 67 who fifteen years previously had received radium treatment for carcinoma of the uterine cervix stage I She had felt well until the year previous to admission during which she had had evidence of cystitis and during the last month haematuria

Cystoscopy revealed cystitis and blood stained urine from the left ureter

Urography the left kidney was of normal size but did not function

Left uretero-pyelography disclosed a somewhat irregular narrowing of the ureter about 2 *cm* in length at the level of L4—L5

FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (DIRECTOR PROF OLLE OLSSON),
LASARETTET AND UNIVERSITY OF LUND, SWEDEN

ANGIOGRAPHIC DIAGNOSIS OF URETERIC CARCINOMA

by

ERIK BOIJSEN

Primary tumors of the ureter are of the same type as those of the kidney and urinary bladder, the most common form being the papillary carcinoma, which is built up of transitional cells The stroma of the transitional cell carcinoma of the urinary tract is richly vascularized (LARGIADER 1958) and, for this reason, angiography can show not only the site but also the local spread of such lesions (BOIJSEN & FOLIN 1961 BOIJSEN & NILSSON 1962)

It was considered that angiography might also be a valuable supplementary method to urography and ureterography in the differential diagnosis of obstruction of the ureter With this in mind we tried the method in two cases of probable carcinoma of the ureter (we thank Docent Gosta Jonsson, Dept of Urology, Univ Lund for his co operation) and now report the results

Case reports

Case 1 Woman aged 73 with a two year history of symptomless gross haematuria the bleeding had ceased before the examination On cystography there was a small clot in the right ureteric orifice

Urography on the same day revealed a comparatively small left kidney with characteristic features of fairly advanced pyelonephritis It was therefore assumed that the source of the bleeding was on the left side despite the cystoscopic finding The outline of the right renal pelvis was normal and the parts of the right ureter which filled showed no evidence of any changes Control cystoscopy revealed no abnormalities

The patient was admitted to hospital because of recurrence of the gross haematuria On cystoscopy blood was seen flowing from the right ureter and urography showed that the

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A coiling of the catheter at the site of the tumor during urography has been described as a sign of ureteric carcinoma (BERGMAN et coll 1961) Such a deformity, however like a filling defect in ureterography, is only an indirect sign of a growth The diagnosis is necessarily based upon some pathognomonic sign of a tumor (OLLE OLSSON 1961) a criterion that is satisfied by the demonstration of tumor vessels and an accumulation of contrast medium in the growth Angiography is therefore a method to be tried in cases of possible tumor of the ureter A definite diagnosis facilitates the planning of surgical treatment because if the tumor is malignant both the kidney and the ureter must be removed unless as in our Case 1 the function of the other kidney is severely impaired

The choice of the type of angiography in a given case depends upon the site of the obstruction The upper part of the ureter is supplied by one or two ureteropelvic arteries arising from the renal artery or its ventral and dorsal arteries The middle part is fed by branches from the ovarian (spermatic) artery and from the common iliac artery The distal part of the ureter is supplied by the vesico vaginal (prostato vesical) artery (DISSE 1902 ROBINSON 1902 SAMPSON 1904) All of these arterial branches freely anastomose with one another If the upper part of the ureter is involved the examination should be performed as selective renal angiography and, if the middle part as lumbar aortography If on the other hand the tumor is situated at the level of the crossing of the ureter with the iliac vessels or lower down the ureter the contrast medium should be deposited in the common iliac artery

SUMMARY

The application of angiography in the differential diagnosis of ureteric obstruction is described and exemplified by two illustrative cases in which the method enabled a definite diagnosis of carcinoma of the ureter to be made

ZUSAMMENFASSUNG

Die Anwendung der Angiographie bei der Differentialdiagnostik von Ureterobstruktionen wird beschrieben und durch zwei Falle illustriert, bei denen die Methode es ermoglichte die Diagnose eines Ureterkarzinomes zu stellen

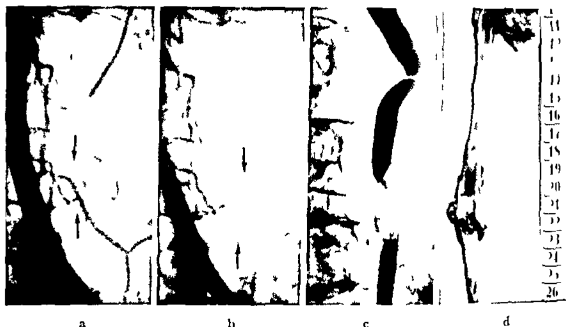
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a b c d

Fig. 2 Case 2 Poorly differentiated transitional cell carcinoma situated in middle part of ureter a) and b) Aortic angiography Vessels arising from the common iliac artery and supplying the tumor seen on ureterography (c) with small tumor vessels d) Operation specimen

Selective renal angiography the renal artery and its branches were displaced by the widened renal pelvis and reduced in width A widened uretero pelvic artery branching from a narrow dorsal artery was traced to the site of the stenosis No tumor vessels could be detected The uretero pelvic vein was found to be widened in the venous phase

Aortic angiography revealed an area of tumor vessels measuring about 2 cm by 2 cm at the level of the stenosis seen at ureterography These vessels arose from the left common iliac artery Operation Uretero nephrectomy was performed

Pathologic examination primary poorly differentiated transitional cell carcinoma of the left ureter growing through the muscular layer to the periureteric tissues

Discussion

A definite pre operative diagnosis of carcinoma of the ureter has previously been made only histologically and only if the tumor protruded through the ureteric orifice could a specimen be removed for microscopic examination

Urography and ureterography can demonstrate tumors of the ureter, but a definite diagnosis is often difficult (SENGER & FUREY 1953, SAVIGNAC 1955, ABESHOUSE 1956, OLLE OLSSON 1962) According to SCOTT (1954) about two thirds of all primary ureteric tumors are diagnosed before operation The roentgenographic appearances are not always typical and may be difficult or impossible to distinguish from those of a non opaque stone or a blood clot (as in Case 1) or from local ureteritis or periureteritis or some other stenosing process such as tumor metastases or post radiotherapeutic fibrosis (as in Case 2)

A coiling of the catheter at the site of the tumor during urography has been described as a sign of ureteric carcinoma (BERGMAN et coll 1961) Such a deformity however like a filling defect in ureterography, is only an indirect sign of a growth The diagnosis is necessarily based upon some pathognomonic sign of a tumor (OLLE OLSSON 1961), a criterion that is satisfied by the demonstration of tumor vessels and an accumulation of contrast medium in the growth Angiography is therefore a method to be tried in cases of possible tumor of the ureter A definite diagnosis facilitates the planning of surgical treatment, because if the tumor is malignant both the kidney and the ureter must be removed unless as in our Case 1, the function of the other kidney is severely impaired

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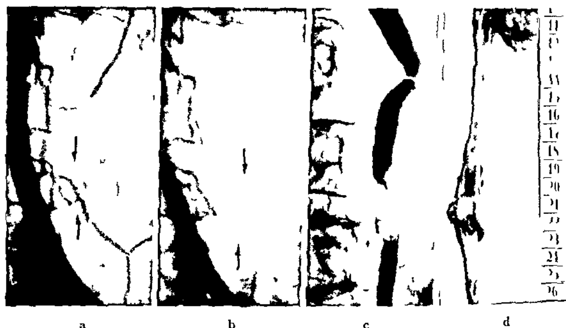
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Die Anwendung der Angiographie bei der Differentialdiagnostik von Ureterobstruktionen wird beschrieben und durch zwei Fälle illustriert bei denen die *Methode es ermöglichte* die Diagnose eines Ureterkarzinomes zu stellen

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FROM THE ROENTGEN DEPARTMENT (DIRECTOR PROF K LINDBLOM), KAROLINSKA SJUKHUSET STOCKHOLM, SWEDEN

BENIGN TUMOURS OF THE STOMACH AND DUODENUM

by

O EKLOF

A widening in the indications for roentgen examination of the stomach and duodenum improvements in film and apparatus and refinements in methods of examination resulting from greater experience have all led to a steady rise in the number of tumours demonstrated roentgenographically The increase has been proportionally highest in the case of benign tumours (cf ELSTERMAN 1944 BOCKUS 1946 MONES et coll 1954 KIEFER & CHRISTIANSEN 1956 JONES & GUMMER 1960 BUCKER & STOSSEL 1961) with a consequent relative reduction in the number of malignant growths according to some reports this reduction represents in effect a decrease in their incidence (HAENZEL 1958 HENSCHEN 1960 OCHSNER et coll 1961)

Research has however hitherto been focussed chiefly on the malignant tumours the poor prognosis of which has made it of vital importance to find new methods of treatment and to improve those already available As a result interest in the benign growths has rather tended to be less than would appear warranted by their incidence and clinical importance Many roentgenologic and clinical textbooks still describe them as rare (JOHNSTONE 1950 SCHINZ et coll 1952 MONES et coll PALMER 1957)

A considerable proportion of tumours of the stomach and duodenum are primarily benign estimates of 15 per cent or more have been given in recent

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clinical works (COOLEY & STEMBRIDGE 1955 MARSHALL 1955, CHAJKOV 1957, DAVIES & JACKSON 1959, EKLUND et coll 1961)

Since deviating views have been expressed as to the possibility of roentgen diagnosis of benign tumours of the stomach and duodenum, and as the differentiation of the various tumours is still under discussion (MOORE 1924, FORSSMAN 1943, COLE 1953, MONES et coll, OTTOMAN et coll 1955, JAMES 1956, PREVOT & LASSRICH 1959, ROBERTS et coll 1959, BUCKER & STOSSEL, PERRY & SHFKARCHI 1961), a report on our experiences in a large material may be of interest The feared complication of malignant degeneration as well as certain other important features will also be considered

Material The series comprised 221 cases with abdominal symptoms and in which one or more benign tumours of the stomach or duodenum were diagnosed The material was collected by re examining roentgen films and going through case records and operation, gastroscopy, and autopsy reports from the period 1940 to 1960 inclusive All the cases were examined roentgenologically on one or more occasions The roentgen diagnosis of tumour was verified histologically from operation specimens in 94 cases, at gastroscopy in 7, and at autopsy in 13 cases In the remaining 107 cases the diagnosis was based solely on the roentgen findings and the clinical features

The tumours in the 221 cases were classified as shown below, according to *the roentgen, biopsy gastroscopy or autopsy findings*

A number of lesions termed pseudo tumours, i e an accessory pancreas and certain postoperative growths simulating true tumours are included owing to their interest from the clinical and differential diagnostic viewpoints

A further 13 cases of benign tumour of the stomach and duodenum were diagnosed during the relevant period but were rejected for various reasons Two cases on roentgen examination had deformation of the duodenal bulb

True tumours	
I Epithelial tumours	
a) Polyps	166 cases
b) Carcinoid tumours	3 »
II Non epithelial tumours	
a) Leiomyoma	10 »
b) Neurinoma	2 »
c) Neurofibroma	2 »
d) Poorly differentiated tumours whose origin (myogenic or neurogenic) could not be determined	6 »
e) Lipoma	6 »
Pseudo tumours	
I Accessory pancreas	23 »
II Postoperative plication deformity with foreign body granuloma	3 »

which masked the demonstration of an accessory pancreas found later at operation In a third case a poorly differentiated non epithelial tumour was an incidental finding at partial gastrectomy for duodenal ulcer, the roentgen examination had disclosed pyloric stenosis In nine cases of polyps in which the roentgen findings were verified histologically following operation and in one in which gastroscopy provided confirmation, the films were not available for re examination

Clinical features Benign tumours of the stomach or duodenum were roughly equally common in the two sexes Most of the patients belonged to the cancer age groups and were 40 years of age or over it is rather uncommon for benign tumours to be found in patients under 20 years of age although they have occasionally been reported (HEGGO 1957) The series included three patients in whom polyps were found at the age of 21 to 22 years, although the mean age of the patients with polyps was otherwise the highest i e 62 3 years when the diagnosis was made The youngest patients were those with an accessory pancreas of whom about half were under 40 when the diagnosis was established

Benign tumours of the stomach and duodenum are generally symptomless and are an incidental finding (WATSON et coll 1959) In the present series the symptoms often arose from disorders of the biliary tract and sometimes from peptic ulcers these latter being especially common in the accessory pancreas cases As regards polyps the achlorhydria present in some 85 per cent of cases and the atrophic gastritis demonstrated by many investigators should be borne in mind as causes of symptoms Achlorhydria in association with benign tumours other than polyps was an inconstant finding In some instances the tumour may constitute a mechanical obstruction owing to its situation or size

An important sign is anaemia with or without bleeding Iron deficiency anaemia deriving from impaired absorption and a reduced ability to utilize iron commonly accompanies polyps (RINTALA & NYLUND 1958) and is probably connected with the achlorhydria (DAVIDSON & MARKSON 1955 BADENOCK et coll 1957) The possible presence of idiopathic pernicious anaemia should also be remembered (cf EKLOF et coll 1960, 1962)

However the anaemia is very often due to haemorrhage which is frequently present without other accompanying signs and may be recurrent in some instances there is no difficulty in detecting the source as being an ulcerated benign tumour while in others roentgen examination may fail to demonstrate the source of bleeding despite the demonstration of a tumour

Histologic examination of operation specimens strikingly often revealed circulatory disorders with mucosal necrosis and superficial erosions in or close to tumour area — which accounted fully for the haemorrhage in those cases Massive melaena or haematemesis was uncommonly associated with polyps,



Fig 1 Benign pedicled adenomatous polyp in the pyloric antrum (Histologically verified)

in approximately half the cases of polyp with occult melaena, the tumour showed malignant degeneration On the other hand, massive haemorrhage was fairly common in tumours which were non epithelial and in which there was no suggestion of malignant degeneration

Technique of examination Although the technique of roentgen examination of the stomach and duodenum has now reached a recognised standard, certain points should be stressed Mucosal relief pattern roentgenograms are always required, as are films showing the stomach filled Double contrast examinations with barium emulsion and gas, or with gas inflation alone, are of particular value in these cases and not merely for the study of the forms of the stomach The tumours should be shown in profile for study of their attachment as well as en face The exposure must be sufficiently short so that no blurring occurs The stability of the emulsion is also of importance to the results, variations in its density should be avoided, and the specific gravity should be carefully controlled MATTSON's barium test aerometer (1953) has proved most helpful, in the preparation of the emulsion



Fig 2 Benign adenomatous polyps in small aggregations in body of stomach (Histologically verified)

Roentgen findings

Changes associated with true tumours

Polyps constituted the largest and most important group in the series They accounted for some three quarters of all cases of benign tumour and had the greatest tendency to malignant degeneration

Polyps appeared on the roentgenograms as more or less well defined defects in the mucosal folds (Figs 1 2 and 7) The mucosal relief varied widely in the individual cases from total atrophy of the mucous membrane (Fig 3) with loss of pattern to coarse, irregular hypertrophic folds Alterations in the mucosal pattern between examinations were noted

Polyps of the stomach were multiple in more than 50 per cent of cases while multiple polyps of the duodenum were evident in one case (Fig 4) The number of polyps varied from a few within a limited zone to numerous tumours in minor aggregations (Fig 2) spread over large areas of the gastric mucosa The most usual sites were the greater curvature at the angulus and the distal portion of the body of the stomach followed in order of frequency by the rest of the body of the stomach and the pyloric antrum Polyps accounted for two thirds of the tumours of the duodenum in the series In only one instance was a polyp found at the fornix of the stomach (Fig 8)

The size of the polyps varied appreciably diameters ranging from a few millimetres to between 5 and 6 cm most of them however were less than 2 cm in diameter The small polyps were rounded and were well defined, with a smooth surface (Figs 1 and 7) while the larger ones were often lobulated (Fig 7) irregular (Fig 5) and more or less cauliflower like in contour (Fig 6) Multiple polyps usually varied similarly in shape and size (Figs 2 and 7)



Fig 3 Marked mucosal atrophy with diffuse mamelonation of the mucous membrane



Fig 4 Multiple polyps in the duodenal bulb

In broad based polyps, the width of the attachment mostly corresponded to the total diameter measured, and little mobility was present However, there were also a number of pedicled polyps with narrow stalks and greater mobility (Fig 1), in one case only, a polyp of this type led to blockage of the pylorus with accompanying signs of stenosis

Peristalsis was usually normal, but in regions exhibiting widespread polypoid changes and in the presence of large polyps peristalsis was in some instances shallow or even absent Some rigidity in the contour of the stomach wall, with depressions and deformations, were evident in a few cases but was not necessarily suggestive of malignancy (Fig 6), even if malignant degeneration often accompanied these features

Ulcerations was not demonstrable roentgenographically with any confidence in cases of small polyps although there was a history of melaena in some instances As mentioned earlier the bleeding arose in some cases from superficial erosions but was not infrequently attributable to malignant neoplasms elsewhere in the alimentary tract Consequently, the detection of one or more polyps should never satisfy the examiner, the aim must always be to rule out malignancy Some large polyps showed ulcerations of varying shape and size, these polyps usually had malignant changes No calcification of polyps was recorded

Carcinoids of the stomach are very uncommon It is not possible to distinguish them roentgenographically from other tumours of the stomach, but evidence of the carcinoid syndrome should point to the diagnosis The three carcinoids in the series were all solitary In two instances they were well defined, broad based, rounded tumours, about 3 to 4 cm in diameter, situated in the body of the stomach and producing defects due to a more or less sharp



Fig 5 Two large somewhat irregularly demarcated broad based adenomatous polyps in middle third of stomach Malignant degeneration at histologic examination



Fig 6 Large broad based cauliflower like tumour on the greater curvature side of the angulus, with a depression in the wall corresponding to the tumour attachment Premalignant adenomatous polyp at histologic examination

interruption of the mucosal folds close to the tumour (Fig 9) The third carcinoid lay at the fornix had a broad base was sharply defined and bulged into the lumen of the stomach All three tumours were ulcerated

The non epithelial tumours irrespective of their histologic type presented appearances that were dependent entirely on the manner of growth and in some measure on the situation of the tumour Those of chiefly exogastric or exoduodenal growth brought about only deformation or displacement of the organ while those of endogastric or intramural growth consisted of more or less sharply defined rounded or oval soft tissue masses protruding into the lumen (Figs 10 13 15a and b and 17) The tumours at the fornix were in several cases broad based and well defined with a frequently smooth but at least equally often lobulated or even slightly irregular surface



Fig 7



Fig 8

Fig 7 Rounded sharply defined tumour with a somewhat irregular surface proximal to the with an attendant smaller tumour with smooth surface Benign adenomatous polyps at hist examination 13 years after partial gastric resection for neurinoma (?) of the stomach

Fig 8 Double contrast examination Broad based clearly demarcated tumour with a s irregular surface close to the cardia (Histologic examination malignantly degenerated adenom polyp)

All the non epithelial tumours in the series were solitary and ranged in from 18 mm to 15 cm, most of them exceeded 2 cm in diameter The ne genic and myogenic tumours were fairly evenly distributed throughout different parts of the stomach, and two of them were found in the duode (Fig 10) All the lipomas lay in the pyloric antrum

The tumours usually had wide attachments but one myogenic tumour pedicled and on roentgen examination could be displaced between the pyl and the duodenal bulb It gave rise to intermittent pyloric stenosis Altho they were broad based, several other tumours were strikingly mobile as c pared with, for instance, the epithelial tumours in the series This was e cially true of the lipomas

The mucosal pattern in the vicinity of the tumours showed no character feature The folds could often be identified up to the tumour and were placed in a curve around it (see Fig 17) In other cases they were seen t stretched or flattened by the expansive growth of the tumour, but there w



Fig 9 Carcinoid broad based ulcerated tumour on the lesser curvature distal to the cardia (Histologic verification)



Fig 10 Clearly demarcated rounded tumour with smooth surface large central irregular ulcer (Histologic examination poorly differentiated probably malignant myogenic tumour)

also instances in which the mucosal folds appeared to be interrupted by the tumour which was consequently difficult to differentiate from the epithelial neoplasms

Data on peristalsis were lacking in several cases while in others the variations were wide from fully normal, moderately decreased to complete absence of peristalsis in the tumour region

Ulcerations were a common complication (Figs 10, 13 and 15a) Their number size and shape ranged from small solitary and well defined ulcers to multiple large irregular craters Neither the appearance nor number of the ulcerations was of any help in distinguishing between different tumour forms or assessing malignancy Calcification of the tumour was recorded in only one case this was a poorly differentiated probably neurogenic tumour of chiefly exogastric growth which deformed and displaced the fornix

Changes associated with pseudo tumours The series comprised 23 cases of accessory pancreas a fairly common congenital anomaly which has frequently been mistaken for true tumour but the characteristic roentgen appearances of this malformation should in the great majority of cases permit of its differentiation

On roentgen examination the accessory pancreas had the appearance of a broad based sharply defined rounded or oval tumour like formation with a diameter seldom exceeding 2 cm as measured in the roentgenogram and often



Fig 11



Fig 12

Fig 11 Postoperative plication deformity with foreign body granuloma Part of the gastric stump forms a pouch which hangs down past the retrocolic gastroenterostomy Fairly well defined somewhat irregular defect on the lesser curvature just proximal to the stoma this appears to compress as well as to interrupt the mucosal folds Probable ulceration present (Histologic verification)

Fig 12 Bezoars Two to three clearly defined rounded mobile defects in the stomach At operation undigested orange segments with skin found

appreciably less Depending on the projection, pooling of contrast medium or duct like structures of varying calibre and length were seen in the accessory pancreas (Fig 14b) In some instances, this so called pancreatic duct' showed clubbing distally and sometimes small ramifications as well The diagnosis of accessory pancreas can be made only when the duct is filled with contrast medium The characteristic situation of the small broad based, rounded contrast defect 'within 5 to 6 cm of the pylorus (MARTINEZ et coll 1958, ROONEY 1959) may be taken as suggestive of this anomaly even when the duct system is not outlined

Peristalsis was in some instances reported to be somewhat shallower in the region of the malformation than elsewhere in the stomach, but this is a sub



Fig. 13 Benign myogenic tumour of stomach. Large clearly defined tumour fills the greater part of the stomach. Slightly irregular surface not unlike that associated with certain bezoars with three large irregular areas of ulcerations. (Histologic verification.)

jective assessment and difficult to evaluate owing to the frequent vagueness of the changes.

In uncomplicated cases the mucosa in the vicinity of the accessory pancreas exhibited no features deviating from normal. In the presence of the commonest complication — or rather the cause of the symptoms, peptic ulcer — the mucosal changes characteristic of *that condition* were found. Ulceration of the accessory pancreas itself was not observed.

In rare cases tumour-like growths may be demonstrated at the site of suture even long after gastric operations; these are usually seen close to the stoma of the gastroenterostomy. In two cases with changes of this type in which re-



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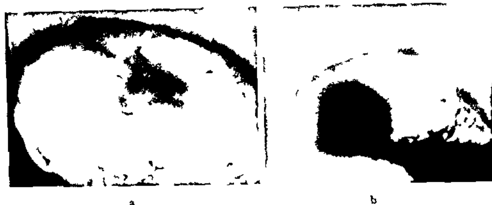


Fig 15 a) Benign myogenic tumour Double contrast examination ulcerated broad based well defined tumour bulging into the fornix of the stomach b) Malignant myogenic tumour Broad based well defined rounded tumour with slightly irregular surface on the lesser curvature close to the fornix (Histologic verification in both cases)

peristalsis in relation to the changes were available One of the pseudotumours (Fig 11) appeared in some of the films to be ulcerated At operation which was not performed in immediate connexion with the roentgen examination multiple superficial mucosal erosions were found but no true ulceration was apparent

Discussion

Malignancy and benign tumours of the stomach or duodenum The most serious complication of benign tumours of the stomach or duodenum is without doubt malignant degeneration

Malignant degeneration or the coexistence of a malignant gastric tumour with a benign polyp was noted in roughly every fifth patient with the latter condition Furthermore a strikingly high incidence of malignant extra gastric tumours was recorded in these patients (EKLOF et coll *1960, 1962)* The situation and number of the polyps were found to be of some significance in the development of malignancy No malignant degeneration of polyps of the duodenum was recorded in the *series* Of the patients with solitary polyps of the pyloric antrum only one developed malignancy in the gastric stump and then many years after the partial gastrectomy Malignancy in other forms of polyps was appreciably more common and of roughly *equal* incidence — with the exception of polyposis in which the frequency of malignant degeneration was definitely the highest Furthermore malignancy was about ten times as common when the polyps had a diameter of 2 cm or more than when they were smaller and more frequent when they were broad based than narrow The



Fig. 14. a) Pyloric ulcer. Area of ulceration about 1.5 cm at the base and 1 cm deep on lesser curvature surrounded by mucosal swelling. b) Accessory pancreas. Clearly demarcated oval tumour-like mass with a slender duct about 1 cm in length, fine ramifications and slight clubbing on lesser curvature of pyloric antrum.

operation was performed for a probable growth, folds constituting a more or less marked degree of mural duplication were found; these changes have been called plication deformity by SASSON (1960). Histologic examination showed them in our cases to contain foreign bodies with granuloma formation. The series also included a third case, not verified at operation.

Roentgen examination performed in these cases, from three months to 29 years after the initial operation, showed a sharply defined, rounded tumour-like thickening of the wall of stomach ranging in diameter from just over 2 cm to between 3 and 4 cm (Fig. 11). The lesion was in two cases situated on the anterior wall of the lesser curvature side of the gastric stump close to the gastroenterostomy created at partial gastrectomy for peptic ulcer. In the third case the 'tumour' lay in the pyloric antrum at the site of an earlier gastrotomy. The latter neoplasm, which was the smallest, appeared to be pedicled and was appreciably more mobile than the other two which had broad based attachments.

In two of the cases, including the third in which the 'tumour' was thought to be pedicled, the change was very sharply defined from the surrounding tissues and the mucosal folds were interrupted, while in the remaining case (Fig. 11) the folds were seen to be displaced in a curve around the lesion and in some projections appeared to be stretched or flattened. No data on the



Fig 17 Benign neurogenic tumour A clearly defined mass with curved displacement of the mucosal folds in the body of the stomach (Histologic verification)



Fig 18 Broad based defined somewhat irregularly shaped polyp-like tumour of greater curvature at autopsy found to be caused by direct invasion by a pancreatic carcinoma

genic tumour Both the former tumours recurred and produced metastases while the latter case is free from symptoms ten years after the operation

Malignant degeneration of an accessory pancreas is probably very rare if it occurs at all and was not noted in the present series (EKLOF (a) 1961)

Although only a few cases of postoperative plication deformities simulating tumour are on record (FISCHER 1960 EKLOF & OHLSSON 1962) it may perhaps be stated that there is little danger of malignant change as such in these cases The difficulty is to distinguish the changes from true tumours even of the malignant variety

Differentiation of benign tumours A roentgen diagnosis of benign tumour of the stomach or duodenum was in a number of cases based on evaluation of the features of the growths such as their number, situation size, shape and surface the breadth of their attachment, their mobility changes in peristalsis and mural contours the appearance of the mucosal pattern and the presence of complications such as ulceration or calcification The constancy of the findings of consecutive roentgen examinations was many times of diagnostic value bearing in mind variations in projection compression, and the amount of contrast medium

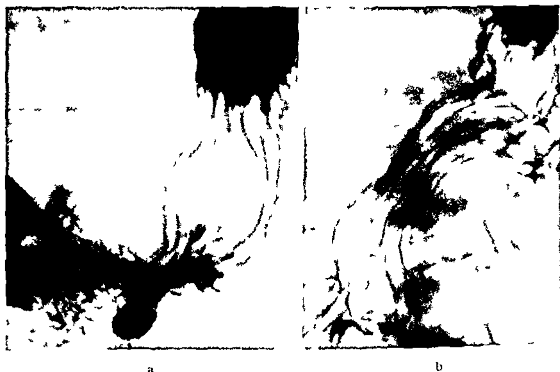


Fig 16 Pancreatic cyst causing an impression in the stomach proximal to the angulus a) Tumour like changes in the gastric wall in region of angulus separating and displacing the mucosal folds in curves b) The change *is seen to* be due to an expansive process at the site of the pancreas displacing the stomach mainly forwards *and to the right* and producing an impression in the posterior wall (Histologic verification)

growth of polyps demonstrated on consecutive examinations is suggestive of malignant degeneration Unfortunately there was difficulty in evaluating this criterion, since differing projection, compression, and contrast media often accounted for the slight variations evident Even in the presence of malignant degeneration, prognosis was fairly favourable (EKLOF et coll 1960, see also BRODERS 1960)

Estimates of the frequency of malignancy of carcinoid tumours of the stomach range in different series from 20 per cent to 34 per cent (RITCHIE 1956, DAVIES 1959) The prognosis is all the same rather favourable, as is suggested by the fact that none of our three cases exhibited signs of recurrence or metastases, although operation specimens in two instances revealed features indicating infiltrative growth (EKLOF (b) 1961 cf also LAITES & GROSSI 1956)

The incidence of malignant degeneration of non epithelial tumours is estimated at different levels in the literature, in most series it is appreciably lower than, for instance, that associated with polyps (EKLUND et coll 1961) In the present series malignant degeneration was demonstrated in two cases of poorly differentiated, probably myogenic tumours, and in one of a neuro

tumours and also some broad based non epithelial tumours, may present diagnostic difficulties, in contrast to ingested material they are usually solitary and of unaltered appearance on roentgen control In these cases a supplementary examination with gas inflation of the stomach may prove most helpful Cases in which bloodclots have simulated a tumour and known to have gastro intestinal bleeding have also been described (OLSSON 1942 LENTINO & PRINCIPATO 1956) Negative roentgen findings on repeat examination after a few days have lent support to the diagnosis

In some case of gastric ulcer the surrounding mucosal swelling may be so marked as to give the impression of a sharply defined tumour with central ulceration (Fig 14a), minor changes of this type may be due to an accessory pancreas (Fig 14b) In these cases too, any changes noted between consecutive examinations are of significance although a tumour like deformation may often persist after the ulcer has healed

The difficulty of distinguishing between different tumours at the fornix is appreciable and often greater than that pertaining to tumours in other situations Most of the neoplasms diagnosed in this region in the present series were of a character as to indicate immediate operation massive haemorrhages were frequent (Fig 15) The series suggests adenomatous polyps to be uncommon at the fornix of the stomach, which otherwise may be the site of practically any other tumour

Gastric varices bulging into the gastric lumen to give the appearance of sharply defined soft tissue tumours have been reported although in these advanced cases the oesophageal changes characteristic of varices should point to the correct diagnosis (GUTGEMAN & PARCHWITZ 1959, SCHAFER 1959) Lienal phlebography may be helpful in the diagnosis I found no case of this type in the material

Extra gastric processes may lead to deformation of the stomach and simulate tumours This is particularly true of pancreatic cysts which, in some projections (Fig 16) may resemble non epithelial tumours Such cysts may under certain circumstances empty through the pancreatic duct or out into the abdominal cavity when the roentgen changes will disappear Cysts of the pancreatic tail may sometimes deform and displace the fornix and body of the stomach in the same manner as non epithelial tumours of exogastric growth In rare instances malignant tumours of adjacent organs may directly invade the gastric mucosa leading to appearances impossible to distinguish from those of polyps (Fig 18) This was also true of the few cases in which malignant tumours formed metastases in the stomach Metastases into the stomach were said by WALTHER (1948) and WILLIS (1952) to be rare and usually associated with melanoma HARTMAN & SHERLOCK (1961) recently reported a strikingly high incidence of gastric metastases in cases of carcinoma of the breast treated with adreno-steroids however this report has not yet been verified by other investigators



Fig 19 a) Broad based well defined spool shaped tumour with a somewhat irregular surface which was found to be caused by local irregular polypoid mucosal hypertrophy b) Local chronic gastritis The mucosa in a circumscribed zone of the greater curvature is coarse and irregular with some rigidity of outline (Histologic verification in both cases)

Most small duodenal and gastric polyps, as well as an accessory pancreas, could be identified as such But the true nature of larger tumours could hardly ever be determined with confidence owing to their generally appreciably more variable roentgen features Nor was it possible to exclude malignant de generation in these cases

Consequently, the lesions have to be distinguished first and foremost from malignant tumours Most malignant neoplasms of the stomach or duodenum are characterized by an irregular configuration and roentgen signs of in filtrative growth (JOHNSTONE 1950, BUCKSTEIN 1951, SCHINZ et coll 1952) It should be noted, however, that primarily malignant tumours, both epithe lial and non epithelial, may in some instances be extremely sharply defined and present no roentgen evidence of infiltration (cf EKLUND et coll 1961) It is therefore, as stated above, by no means always possible to decide roent genologically whether or not malignancy is present

The tumours must also be differentiated from various intra and extra gastric physiologic and pathologic conditions simulating tumour

Food remnants or ingested tablets are usually readily recognized by their widely deviating appearances in different projections and the fact that they are readily displaced both in relation to one another and to the gastric wall This is also true of most bezoars, which in addition usually have a very easily recognized surface structure (Fig 12) When the mobility of the bezoar is less marked, owing for instance to its size, and in some other circumstances when the history affords no information, the bezoar may be difficult to distinguish from a true tumour (Fig 13) The great mobility of pedicled

tumours were diagnosed in roughly equal numbers in the two sexes Their incidence increased with advancing age the great majority of the patients were over 40 years when the diagnosis was made

The clinical features are often insignificant and the tumours not infrequently found incidentally on examination for abdominal symptoms Anaemia with or without haemorrhage is one of the commonest findings, as is achlorhydria in association with polyps The most serious complication is malignant degeneration which was recorded in roughly every fifth case of gastric polyps in the series Malignant changes were not recorded in duodenal polyps or in an accessory pancreas and was fairly rare in other primarily benign tumours

A solitary, well defined rounded or slightly irregular defect with a diameter of less than 2 cm in most instances indicates the presence of a polyp Multiple defects of the same type often varying somewhat in shape and size arranged in small aggregations or diffusely spread over the gastric mucosa are almost certain to indicate polyps Most pedicled tumours of this size are polyps

The diagnosis of an accessory pancreas usually presents no difficulty if the duct system characteristic of this anomaly is evident on roentgen examination

Certain cases of small non epithelial tumours, of an accessory pancreas in which the typical duct is not filled and some instances of tumour invasion from adjacent organs or of malignant metastases to the gastric mucosa may not be distinguishable roentgenologically from polyps

The roentgen appearances of tumours with a diameter of 2 cm or more are very variable and permit no final differentiation In these cases too however the finding of multiple tumours is indicative of polyps A sharply defined possibly ulcerated freely mobile tumour is in many instances benign and non epithelial and a soft tissue mass close to the anastomosis in a gastrectomy may be a postoperative plication deformity The fact that these medium sized and large tumours especially the non epithelial, are *not diagnosed* at an earlier stage is probably attributable to a long asymptomatic period before necrosis and ulceration develop with consequent haemorrhage as perhaps the *most important sign*

The *size and attachment* of the tumours, and in some measure their situation are of significance when evaluating the danger of malignant degeneration and assessing the indications for *operation* *Broad based* tumours with a diameter of 2 cm or more and multiple tumours i e polyps, had the highest incidence of *malignancy in the main* irrespective of their situation, it is these tumours above all which should prompt operation

In the presence of a solitary tumour with a diameter of less than 2 cm expectant treatment may be *appropriate* The same management seems also to be suitable in cases of multiple small polyps when for some reason operation may be contraindicated *However if* this alternative is chosen, regular roentgen controls should be performed and should at first be at intervals of not more than two to three months If consecutive examinations show

The postoperative stomach raises special problems (Fig 7) If, subsequent to excision or resection for gastric polyps or non epithelial tumours, sharply defined tumour like processes are found, they are most probably tumours of the same character as those prompting the operation and which have been overlooked The discovery of residual tumours is not, in fact, so very unusual Even after resection for ulcer, small polyp like tumours sometimes occur in the stomach, and are said by a number of authors to arise from purely inflammatory conditions (PREVOT 1954) They differ from the plication deformities described in their generally appreciably smaller size, their greater similarity to ordinary solitary or multiple polyps, and in generally being removed from the suture region In other instances there may, instead, be shapeless, grotesque hyperplasia of the mucosa (PREVOT 1954, PREVOT & LASSRICH 1959)

Evaluation is far more difficult when a tumour is detected in the gastric stump following an operation for carcinoma It is only exceptionally that a roentgen examination is capable of indicating whether it is a harmless polyp, some other benign tumour earlier overlooked, a plication deformity, localized hypertrophic gastritis, or a recurrence of the primary growth It should also be remembered that *bezoars and bloodclots simulating tumour* may occur in the postoperative stomach

In this connexion it is worth noting the general difficulty of differentiating roentgenographically between polypoid gastritis (hypertrophic gastritis, hyperrugosity, giant hypertrophic gastritis, 'umschriebene neoplastische Schleimhautschwellungen', 'umschriebene papillomatose Wucherungen', polyadénome en nappe'), polyps, carcinoma of the stomach, and certain forms of lymphosarcoma and malignant gastric lymphomas (Fig 19) (MEULENGRACHT 1913, BADE 1940, SPRIGGS & MARXER 1943, MAIMON et coll 1947, BARDEN 1951, KENNEY et coll 1954, SHERMAN & WILNER 1955, STRODE 1957, FRANK 1957, LOEWENTHAL et coll 1960) Histologic examination of operative specimens in some cases showed the boundary between hypertrophic and adenomatous structures to be fairly indistinct In polypoid gastritis, a period of medical treatment and a further roentgen examination may be helpful in the diagnosis, this may be recommended in patients with long standing moderate gastric symptoms and free hydrochloric acid (STEIGMAN et coll 1957) When more marked symptoms and achlorhydria are present exploratory laparotomy is indicated

Conclusions

Adenomatous polyps were present in three fourths of a material of 221 cases of benign tumours of the stomach and duodenum Non epithelial tumours and cases of accessory pancreas accounted for a fifth of the cases Benign

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no evidence of growth and no signs of infiltration develop, the intervals between examinations may be increased to from six to twelve months Cases of an accessory pancreas require no regular roentgen examinations

SUMMARY

A material of 221 cases of benign tumours of the stomach and duodenum is reviewed The clinical features complications — chiefly malignant degeneration — the roentgen diagnosis, indications for operation and prognosis are considered in detail

ZUSAMMENFASSUNG

Ein Material von 221 Fällen gutartiger Tumoren des Magens und des Zwölffingerdarmes ist nachuntersucht worden Das klinische Bild die Komplikationen — besonders die maligne Entartung — die Röntgendiagnostik die Operationsindikationen und die Prognose werden eingehend besprochen

RÉSUMÉ

L auteur analyse une série de 221 cas de tumeurs bénignes de l estomac et du duodénum Il en étudie en détail les signes cliniques les complications — surtout la dégénérescence maligne —, le diagnostic radiologique les indications opératoires et le pronostic

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FROM THE ROENTGEN DEPARTMENT (DIRECTOR TH ROSENDAL) AND PAEDIATRIC DEPARTMENT (DIRECTOR J VESTERDAL) SUNDBY HOSPITAL, AND THE CHILDREN S HOSPITAL AT FUGLEBAKKEN (DIRECTOR F TUDVAD) COPENHAGEN, DENMARK

ROENTGENOLOGIC CHANGES IN PRIMARY ATYPICAL PNEUMONIA IN CHILDREN

by

O Ch Pock Steen and S Vestermark

During recent years numerous papers have appeared dealing with the clinical serologic, and roentgenologic aspects of so called primary atypical pneumonia or acute interstitial pneumonia (Strom 1955)

The disease ha been considered to be caused by a virus since the classical experiments published in 1946 by The Commission on Acute Respiratory Diseases (7) in which a non bacterial filtrate of nasofaucial secretion from patients suffering from primary atypical pneumonia was inoculated into healthy volunteers and produced typical signs and symptoms But as numerous attempts at its isolation and culture have been as yet unsuccessful the aetiology of primary atypical pneumonia must be said still to be obscure (Gsell 1954) The term virus pneumonia ought therefore to be reserved for such forms of pneumonia as are produced by a well defined virus species e g the influenza virus the more so because the pulmonary diseases for which the latter virus species is responsible seem to differ clinically from primary atypical pneumonia Unfortunately both forms are often described as virus pneumonia, a fact which complicates the differential diagnosis The cold agglutinin titre has been found to be a useful aid in the differentiation this reaction being only weakly positive or more often negative in influenzal pneumonias but generally strongly positive in primary atypical pneumonia (25)

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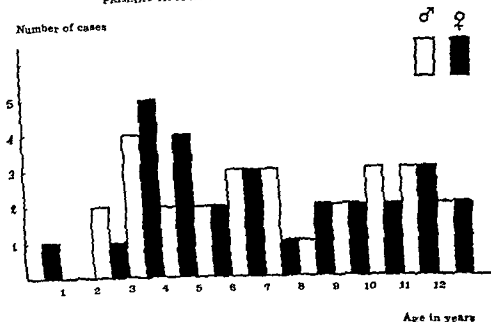


Diagram 1 Age distribution of children with primary atypical pneumonia

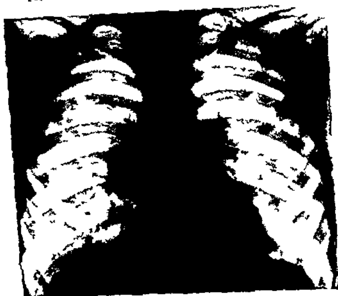
typical features STROM reported peribronchial condensations and striated infiltrates as well as scattered minor atelectases in his cases, while CAMPBELL et coll (1943) and Low (1946), inter alii concluded that enlargement of the hila with striated condensations radiating into the lungs were characteristic of the condition CREER (1948) considered fan shaped condensations radiating from accentuated hila as being of diagnostic significance, the fan shaped figure was stated to end peripherally in infiltrations of low density The authors of the present article have previously (24) also expressed the view that a differentiation between primary atypical pneumonia and other forms of pneumonia especially bronchopneumonia is usually possible roentgenologically BUSER (1953) CAFFEY (1957) HORSFALL (1948), JENNINGS (1950) SHIM (1946) WEISSE (1955) and others are however of the opinion that the changes in primary atypical pneumonia present no characteristic features and are indistinguishable from those seen in other forms of pneumonia At the same time these writers have mentioned certain signs of interstitial pneumonia which are absent in the bacterial forms Thus BUSER characterises the infiltrations as ill defined and JENNINGS as faint and vague while CAFFEY speaks of peribronchial or scattered infiltrations most often bilateral

Our present investigation was undertaken with a view to determining whether there might be roentgenologic appearances which might be considered pathognomonic of primary atypical pneumonia

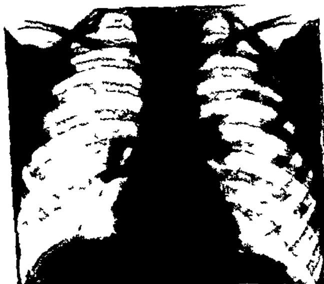
Primary atypical pneumonia is characterized clinically by an acute onset or gradual development of a syndrome comprising fatigue, malaise, headache, dry cough, and a temperature rise. The febrile stage is often stated to last 1 or 2 weeks and a typical feature is the only slightly affected general condition, even when the temperature is high (2, 3, 5, 7, 18, 20, 24). However, reports are also available of cases (among adults as well as children) with a much deteriorated general condition culminating in a fatal issue (20, 23), the general condition is more often affected in infants (22). A dry cough, according to HORSFALL (1948), is present in 98 per cent of the cases, its absence is therefore probably against a diagnosis of primary atypical pneumonia. According to JENNINGS (1953), primary atypical pneumonia, unlike influenzal pneumonia, is rarely associated with catarrhal conditions. Likewise, bacterial superinfection and other complications, such as secondary bronchiectases, are rarer in primary atypical pneumonia than in influenza. Furthermore, primary atypical pneumonia differs from influenzal pneumonias and bacterial pneumonias by running a much milder course, generally without marked cyanosis and dyspnoea. The disease may occur sporadically or epidemically, and all age groups may be affected. HORSFALL and JENNINGS are among the writers who have pointed out the clinical differences between primary atypical pneumonia and the influenzal pneumonias, but REIMANN (1950), JAMES (1953), and others have described the two forms of pneumonia collectively.

Pathology. Post mortem findings in primary atypical pneumonia are rarely reported because the disease seldom runs a fatal course. The relatively few cases submitted to autopsy all presented general inflammation of the peribronchial and peribronchiolar interstitial tissues, with oedema, lymphocytic and mononuclear infiltration, as well as oedema of the alveolar and bronchial walls. The appearances thus differ essentially from those seen in lobar pneumonia and bronchopneumonias, which are characterized by well defined consolidated areas completely void of air owing to exudate in the alveoli and branches of the bronchi. On the other hand, the histologic appearances of primary atypical pneumonia correspond in the main to those of the influenzal pneumonias (1, 16, 17, 23).

Roentgenologic changes. All writers describe the often considerable pulmonary changes that may be seen in primary atypical pneumonia, phenomena which contrast with the only slightly affected general condition of the patients. Various pulmonary changes have been reported. Some writers have focused attention on the marked perihilar lung markings (7, 15), while others have described peripheral infiltrations, most evident in the lower lobes, as characteristic (11, 13, 23). 'The Commission on Acute Respiratory Diseases (7) described 'enlarged hila' and peribronchial condensations followed by infiltrations of relatively low density through which the normal lung markings may be seen, as



a



b

F g 1 Boy aged 4 years primary atyp cal pneumonia a) Bilate al changes n the h lar eg ons w th fan h ped bands rad at ng out wards P ipherally a few mottled nf ltrat ons b) One month later a distu ct per h l fan sh ped nfiltrat on pers t (After another month the h l changes had di nin hed and the lung markings had become almost normal)

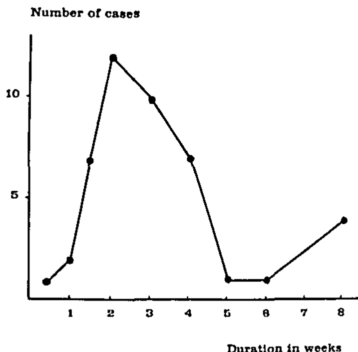
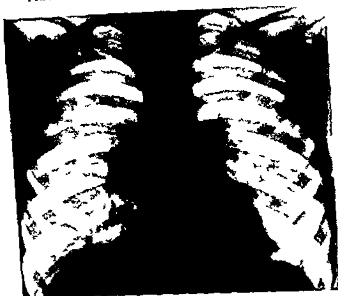


Diagram 2 Duration of the pulmonary changes in 45 children with primary atypical pneumonia

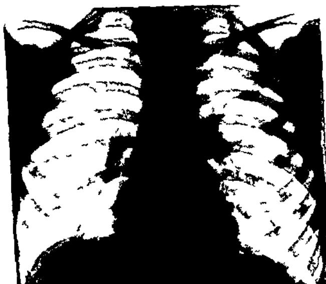
Results

Material The series of cases under review comprise 56 children admitted to our hospitals during the period 1958—1960 We included all cases with clinical signs of primary atypical pneumonia in which the cold agglutinin test gave a titre of 1 32 or higher None of the cases had responded to treatment with sulphonamides or penicillin Bacterial pneumonias therefore appeared to be excluded and the cold agglutinin test eliminated the influenzal pneumonias The ages of the children ranged from 6 months to 12 years, the age distribution is given in Diagram 1

The most conspicuous roentgenographic pulmonary change proved to consist in an accentuation of the normal markings This accentuation, which was a strikingly constant feature, was fine, soft and generally regular The changes were most often bilateral and, although they affected all the lobes in 88 per cent of the cases, were not always of the same degree on the two sides, the markings of the lower lobes were occasionally more evident than those in the remainder of the lung fields In 4 cases only one lung was affected, and in 3 cases only a single lobe In typical cases the accentuated lung markings appeared as a fan shaped infiltration from each hilum This made the hilar regions appear enlarged but, unlike the appearances in hilar adenitis, with no sharp demarcation from the parenchyma of the lung Definite enlargement of the



a



b

Fig. 1. Boy, aged 4 years, primary atypical pneumonia. a) Bilateral changes in the hilar regions with fan-shaped bands radiating outward. Peripherally a few mottled infiltrations. b) One month later a distinct perihilar fan-shaped infiltration persists. (After another month the hilar changes had diminished and the lung markings had become almost normal.)

hilar glands was evident in only one case although it may have been concealed by dense perihilar infiltration in other cases as well In 45 cases (80 per cent) the accentuation of the lung markings extended peripherally in the lung field In 6 cases (11 per cent) the infiltration was only perihilar, in the last 5 cases (9 per cent) the hila were probably normal In some cases the perihilar and peripheral infiltrations were absent at the first examination, but appeared at a later stage of the disease

In addition to these changes small scattered faint and ill defined areas of condensation were observed in many of the cases These were often more or less confluent, particularly in the lower lobes The condensations were of a strikingly low intensity but more massive areas were also seen Such condensations were found in 21 cases (38 per cent), with confluence in half, in some instances they first appeared at the culmination of the disease

An interlobar effusion was evident in 3 cases, basal pleurisy in 1 case, and contracture of the lingula which was considered to be due to atelectasis was observed in a further case, this latter had disappeared on control examination 10 days later In another case massive atelectasis of the right upper lobe which persisted for several weeks was recorded

In 38 (69 per cent) of the 56 cases the accentuation of the lung markings enabled the diagnosis of primary atypical pneumonia to be made with great certainty In 13 cases (23 per cent) the appearances in some respects might have been those of primary atypical pneumonia, in other respects of bacterial pneumonia The remaining five cases (8 per cent) presented appearances which were either normal or most likely those of bacterial pneumonia

Duration of the pulmonary changes Forty five of the cases were controlled In one case the perihilar and peripheral infiltrations disappeared completely after 4 days, in another after 10 days, and four others after about 14 days In 7 cases it took about a month for the lungs to return to normal, and in two cases 2 months In the remaining 30 cases the patients had been followed only until clinical improvement had set in, even if peripheral or perihilar infiltrations were still present in the films The times of disappearance or regression of the pulmonary changes are shown in Diagram 2 These indications of time are thus only minimal figures for the duration of the changes but they show at least that they often persist for a fairly long period

Discussion

The fan shaped perihilar accentuated lung markings found as a quite constant feature in cases of primary atypical pneumonia, *follow the normal bronchial branches* and probably represent peribronchial and peribronchiolar infiltrations (4, 5, 21, 7) The fact that these changes are generally bilateral is in agreement with the findings of general inflammation at autopsy (1, 21, 23) Most writers regard the scattered, ill defined, occasionally confluent areas of

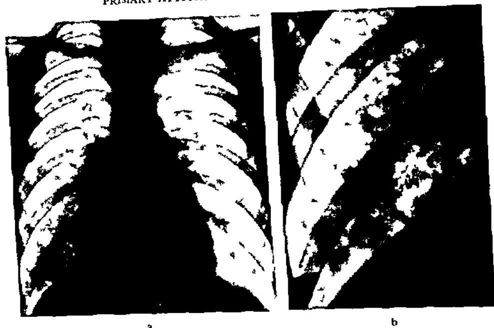


Fig 2 Boy aged 9 years primary atypical pneumonia a) B lateral fa i shaped perih lar infiltration most ma ked on the r ght s de b) Part of the right lower field In sp te of extensi e changes the den ity of il infiltrations s low and the normal lung markings are just d tingui hable indistinct outl nes of th nfiltrations

consolidation as minor atelectases (4 5 21) It would appear that they are more likely to be in the nature of oedematous and infiltrated areas in the interstitial tissue situated outside the air containing bronchial branches The fan shaped peribronchial infiltration and the ill defined disseminated condensa tions merge into one another (8) The blurred outlines of the infiltrations are against their being of an atelectatic nature Primary atypical pneumonia is rarely complicated by a pulmonary abscess or bronchiectasis (21, 22) Bacterial superinfection to be expected if the numerous consolidations represented atelec tases likewise seems to be rare (13) The usually surprisingly good general condition of patients suffering from primary atypical pneumonia, despite some times massive infiltration of the lungs is also suggestive of free air passages Finally it may be mentioned that it has not been possible to confirm the presence of scattered atelectatic areas at autopsy (16 17 23) though a large area of atelectasis occasionally even of a whole lobe may be observed (23) this was found in 2 cases of our series as mentioned The relatively rare oc currence of effusion in our cases is in agreement with the statements of other writers (13) KNUTSEN (1947) reported however pleural effusion in 10 per cent of his cases



Fig 3 Girl aged 10 years primary atypical pneumonia The changes are localised almost exclusively to the right lower lobe where confluence of the numerous peripheral infiltrations is evident

The duration of the pulmonary changes seems to vary considerably In our series they were present from 1 week to over 2 months It is often impossible to decide when the appearances have returned to normal in a condition in which the changes subside so gradually as in primary atypical pneumonia In HORSFALL s series the changes subsided in the course of 1 to 2 weeks GSELL and WEISSE, on the other hand, believed that the changes may persist for up to 8 weeks

Differential diagnosis According to GSELL and JENNINGS the influenzal pneumonias must first be considered The roentgenologic appearances may be very similar and the diagnosis must be established upon the serologic examination The changes described in ornithosis are said to be of the same character (11) It has been stated that the pulmonary changes in bronchopneumonia are indistinguishable from those in primary atypical pneumonia (11, 13, 20) However, the localised or more dispersed consolidations in bronchopneumonia are generally massive and well defined They rarely have the universal character which seems to be typical of primary atypical pneumonia and they are less translucent than the condensations seen in the latter disease Furthermore, the fan shaped perihilar infiltration, so common in primary atypical pneumonia,

is rarely encountered in bronchopneumonia (8, 24). That it may nevertheless in some cases be difficult or impossible to distinguish between the pulmonary changes in the two conditions has been previously mentioned. We have been unable to confirm the view advanced by various writers (3, 7, 11, 19, 23) that the small condensations seen in primary atypical pneumonia may resemble the round circumscribed infiltrations present in miliary tuberculosis.

SUMMARY

The roentgenographic appearances in primary atypical pneumonia in a material of 56 children are described. The differential diagnosis with special reference to bacterial pneumonia and influenza pneumonia is discussed.

ZUSAMMENFASSUNG

Das Röntgenbild der primären atypischen Pneumonie wird in einem Material von 56 Kindern beschrieben. Die Differentialdiagnose bei besonderer Berücksichtigung der bakteriellen Pneumonie und der Influenzapneumonie wird besprochen.

RÉSUMÉ

Les auteurs décrivent les aspects radiographiques de la pneumonie atypique primitive sur une série de 56 enfants. Ils examinent le diagnostic différentiel, en particulier avec la pneumonie bactérienne et la pneumonie grippale.

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Fig. 3. Girl aged 10 years, primary atypical pneumonia. The changes are localised almost exclusively to the right lower lobe where confluence of the numerous peripheral infiltrations is evident.

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PULMONARY WEDGE ANGIOGRAPHY

Experimental investigation in dogs

by

LUIS BECU SVEN PAULIN and EDVARDAS VARNAUSKAS

The causes and site of elevated vascular resistance in various types of pulmonary hypertension have not yet been definitively elucidated, notwithstanding innumerable experimental investigations and postmortem studies (See Pulmonary Circulation An international Symposium) The lack in particular, of comparative anatomico physiologic studies in vivo under normal conditions and in disease greatly handicaps reliable determination of the etiology of pulmonary hypertension

An anatomical investigation in vivo was therefore considered necessary and this paper will be concerned with pulmonary angiography carried out in animals with the purpose of elaborating the technique To facilitate the demonstration of circumscribed wedge areas without overlapping of numerous vascular branches a modified pulmonary wedge angiography technique was employed (BELL et coll 1959 BOLT & RINK 1960 LOHR et coll 1959)

According to BELL et coll pulmonary wedge angiography is not entirely without risk in human subjects and does not appear always to afford readily interpretable results The factors responsible for these shortcomings as well as the results of pulmonary wedge angiography in dogs with special reference to various physiologic and technical considerations will be dealt with in this communication

Submitted for publication 18 October 1961

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Fig 1 Pulmonary wedge angiograms on injection of 0 9 ml Urografin 60 % with concurrent pressure recording a) The pressure calculated at the catheter tip is 5 mm Hg higher than the pulmonary wedge pressure b) Injection rate so raised that pressure at catheter tip exceeds wedge pressure by 25 mm Hg Filling of arterial vessels in the relevant lung segment Homogeneous contrast filling of the periphery outflow of medium through the veins For comparison with vessel calibers the catheter diameter is 3 mm

The angiographic appearances were not altered by variation of the injection rate and hence of the injection pressure within a certain range Injection of medium at the rate of approximately 5 ml/min equivalent to a pressure of less than 10 mm Hg at the catheter tip produced incomplete medium filling of the occluded vascular area Not until the injection rate had been increased to 8 ml/min did we obtain complete contrast filling of all the arterial branches capillaries and appurtenant veins A further increase to 20 ml/min corresponding to a pressure of between 19 and 25 mm Hg at the catheter tip, failed to alter the angiographic pattern

At an injection rate of 40 ml/min or more, equivalent to a calculated pressure of at least 30 mm Hg distinct signs of a pulmonary lesion appeared in the eight angiograms that were obtained In one instance in which a high injection rate was tried the catheter recoiled to a free position in the pulmonary artery and evaluation was not possible No lesion was detectable however (Fig 2)

Pulmonary lesions were characterized by the absence of a regular and homogenous contrast medium deposit at the periphery and the superimposition of irregular and more dense accumulations of medium of varying size over the filled vascular branches With the onset of the pulmonary lesion, filling of the drained veins either decreased or disappeared Following retrac

Method. The angiographic examinations were performed in anesthetized dogs (nembutal intravenously) with spontaneous respiration. A No. 10 heart catheter (Cournand) was introduced via a femoral vein and advanced under fluoroscopic control until its tip was situated in a peripheral pulmonary artery suitable for the examination. A careful check was made by pressure measurement to ensure that the catheter tip had completely occluded the peripheral artery (pulmonary wedge position). The catheter was then connected to a motor-driven automatic injection syringe which permitted injections of constant amounts per unit time. This syringe was in turn linked via a three-way cock with a pressure manometer (Elema) whereby the pressure could be recorded during the course of an injection. The pressure at the catheter tip was obtained by subtraction of the predetermined fall of pressure in the catheter.

The contrast solutions consisted of Urografin (Schering) 30, 60 and 76 % and Thorotrast (Testagar & Co. Detroit).

Material. Nine apparently healthy dogs ranging in weight from 15 to 25 kg were used for the investigations. Three of them were repeatedly examined at intervals of at least one week. In all 46 controlled injections of contrast medium in various pulmonary wedge positions were given.

Roentgenographic technique. The exposures were made with an under couch tube (focus 1.2 × × 1.2 mm, film focus 100 cm) and with the dog supine. To obviate motional blur the time was set at 1/100 sec. Intensifying screens of the very finest grain (Siemens Rubin) were employed to secure maximum detail in the angiogram. Raising of the tube voltage to a value in excess of approximately 90 kV resulted in such an impairment of contrast that this voltage was in no case exceeded. In order to heighten the resolving power in the angiogram we refrained from using any type of secondary grid but reduced the image field to a minimum; the lung segment to be examined was placed as close to the film as possible. The exposures were recorded concurrently with ECG tracings and pressure curves. Each examination comprised ten to twelve exposures spaced at intervals of 5 to 10 seconds.

In the first five animals simultaneous exposures were made in two planes (Gidlund Elema roll film changer). Since, however, the unavoidable secondary radiation greatly impaired the quality of the angiogram, we had to abandon that mode of procedure.

Results

By means of a correct application of the abovementioned method both the arterial and venous vessels in the vascular zone occluded by the catheter tip may be demonstrated.

Veins with a larger caliber than lobular veins are not satisfactorily filled with contrast medium, this being due in part to contrast medium sedimentation (KJELLBERG 1943) and in part to incomplete mixture of the medium, attributable in turn to the fact that the larger veins drain other capillary regions besides the one occluded. The finest vascular branches that could be measured in this study has diameters of approximately 0.1 mm. Although differentiation of individual capillaries is not possible, the capillary bed itself can be shown as a diffuse and homogeneous contrast medium deposit which immediately disappears when irrigation is performed with physiologic saline or when the catheter tip is retracted to the pulmonary artery. The wedge pressure before ... remains unchanged (Fig. 1).

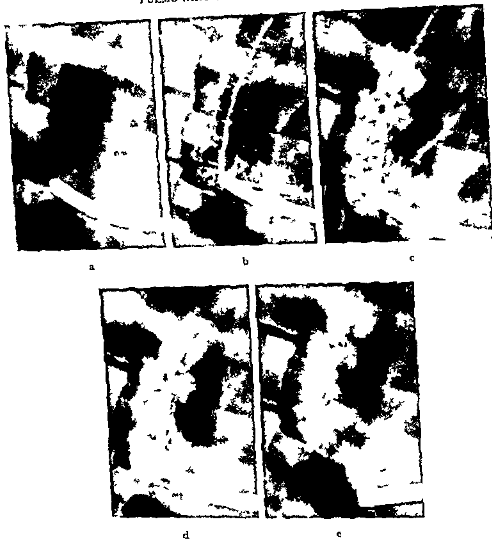


Fig. 3. a) *Catheter in pulmonary wedge position for 25 min.* Roentgenogram taken immediately be… fore injection of medium. b) After injection of 2 ml Urografin 60 … the calculated pressure at th… catheter tip was 5 *mm Hg higher than the wedge pressure.* c) After injection of 4 ml contrast medium at the same injection pressure as in (a) and (b): slight increase in diameters of the large arterial branche… and irregular mottled *accumulation of medium* at the periphery. d) An additional 2 ml have bee… injected. Heightening of the *irregular contrast* accumulation at the periphery. Only small amounts … medium have entered the veins. e) 5 min after completion of injection and retraction of catheter … substantial quantity of medium remains in the area.

contrast injection directly into the pulmonary artery (BLUM & QUARZ 195… BOLT & RINK 1951, BOLT et coll. 1957, CICERO & DEL CASTILLO 1956) resul… in an extremely unsatisfactory demonstration of small vascular branche…



Fig 2 a) Injection of Urografin 60 % into a pulmonary artery branch occluded shortly before by the catheter (Duration of occlusion less than 5 min) High rate of injection The pressure at the catheter tip was estimated to exceed the wedge pressure by more than 30 mm Hg Irregular and mottled filling of the periphery b) Injection discontinued The artery is less distended than in (a) and the medium has left the veins c) 5 min after termination of injection and retraction of catheter an appreciable amount of medium still remains at the periphery

tion of the catheter to the pulmonary artery the medium was not eliminated from the area, a diffuse contrast deposit with no discernible vessels remained A relatively swift absorption of the medium then proceeded for the first hour, though some dense areas of parenchyma with a density less than that of the original contrast medium persisted longer and were observed fluoroscopically for several hours

The pulmonary wedge angiograms exhibited similar patterns in all instances (thirteen) in which the wedging time exceeded 20 minutes, irrespective of whether the injection rate had been high or low (Fig 3)

The occurrence of a pulmonary lesion after injection at a high rate, or after a prolonged wedging time, was not dependent on the concentration of the contrast medium (Urografin 30, 60 and 76 %) Even after injection of Thorotrast at an excessively high rate, corresponding lesions were observed

In one of the dogs in which a pulmonary lesion had been produced, an ipsilateral pneumothorax was noted two days after the experiment

Discussion

Several different angiographic methods of varying value for charting the pulmonary circulation have been reported The most common of them, with



Fig 4 a) Angiogram from same series as in fig 1 Contrast medium was injected continuously over a period somewhat exceeding 3 min the total dose being more than 30 ml Urografin 60 Comparison with fig 1b reveals no conspicuous differences b) Another pulmonary wedge angiogram one hour later of the same area of lung as that depicted in figs 1a 1b and 4a The site of occlusion by the catheter is now somewhat proximal to that in the earlier examinations Irregular contrast distribution at the periphery of the zone previously angiographed No detectable changes in those segments which the injection is now reaching for the first time Five minutes after retraction of catheter no medium remained

5 min intervals or with prolonged single injections of large doses reveal a mild vascular reaction consisting of slight dilatation and irregular contrast filling at the periphery There is a certain analogy with the vasodilator effect of similar contrast media as reported by KAGSTROM & LINDGREN (1960) and by LINDGREN & TORNELL (1958) However no pulmonary lesions were noted in any of these experiments (Fig 4)

The pulmonary lesions observed thus do not appear to have been due to the contrast medium per se Such lesions were in the case of protracted occlusion or excessively rapid injection detected very shortly after the injection when only small doses of medium had been given Examinations with different contrast media in different concentrations yielded on the whole like results

Satisfactory filling of vessels along with angiograms of good contrast were obtained primarily with Urografin 60 % injected at rates varying between 8 and 30 ml/min equivalent to a pressure of 10 to 25 mm Hg at the catheter tip

mainly because of superimposed structures and because of sedimentation and dilution of the contrast medium

Although such modifications of the latter technique as selective lobar pulmonary artery angiography (LOHR et coll 1959), unilateral occlusion of the pulmonary artery (NORDENSTROM 1954), and elevation of the intrabronchial pressure (NORDENSTROM 1960) in some degree lessen these shortcomings, they do not eliminate them

With pulmonary wedge angiography, on the other hand, the diagnostic potentialities are greatly enhanced and vascular branches of as small a caliber as approximately 0 1 mm can be subjected to analysis The production of such a detailed pulmonary wedge angiogram, comprising even the capillary bed, requires, however, meticulous control of the injection pressure as well as an adequate roentgenologic technique A prolonged wedging time, and an unduly low or high injection rate may alter the angiographic pattern to such a degree as to cause difficulties in interpretation, moreover, damage to the lung parenchyma may ensue On irrigation of the occluded vascular area with physiologic saline, or on retraction of the catheter tip to the pulmonary artery, the contrast medium present in the wedge should be immediately flushed away If this fails there will be reason to suspect that the procedure may have caused an alteration in the vascular pathway In such a case the medium will remain in the area, either intra- or extravasally In the absence of necropsy the exact nature of the lesions cannot be determined It may be assumed, however, that the initially rather swift decrease in density points to elimination of the medium from the area, whereas the slight density that frequently remains for several days is a manifestation of local edema and tissue injury attributable to the hypertonic solution employed

Two factors have an important causal relationship to the 'pulmonary lesion', one of them is 'prolonged wedging' and the other an excessively high injection rate The former has the effect of shutting off the relevant lung segment for some time from the normal pulmonary circulation, and the result may be damage to the vessel wall All this is consistent with experience in heart catheterization of human subjects, in whom local pulmonary lesions have followed recording of the pulmonary artery wedge pressure

Our injections of contrast medium at a high rate probably resulted in mechanical damage to the walls of the smallest arteries or of the capillaries, thus facilitating extravasation of medium and blood, with a secondary tissue reaction

In pulmonary wedge angiography with Urografin 60 % and an injection rate of 45 ml/min the pressure at the catheter tip is approximately 30 mm Hg This value substantially exceeds the precapillary pressure normally obtaining and approximates a pressure conducive to pulmonary edema

The irritant effect of the contrast medium must also be taken into account in this context Experiments with repeated injections of small amounts at

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PULMONARY CIRCULATION An international symposium Edited by Wright R Adams and Ilza Veith Grune and Stratton New York and London 1959

SUMMARY

Nine dogs were subjected to a total of 46 injections of contrast medium through a catheter in a pulmonary artery wedge position with *simultaneous recording of the pressure. On angiography* with a technically correct procedure the vascular area occluded by the catheter tip was satisfactorily demonstrated but marked changes were observed when the procedure was experimentally altered. The mechanism of these changes is discussed.

ZUSAMMENFASSUNG

Insgesamt 46 Injektionen eines Kontrastmittels wurden 9 Hunden durch einen Katheter in einer Arteria pulmonalis Keillage bei gleichzeitiger Druckmessung gegeben. Bei Angiographie mit technisch korrekter Durchführung wurde das durch die Katheterspitze okkludierte Gefässgebiet zufriedenstellend dargestellt. bei experimentellen Veränderungen der Methode wurden jedoch deutliche Veränderungen beobachtet. Der Mechanismus dieser Veränderungen wird besprochen.

RÉSUMÉ

Neuf chiens ont subi un total de 46 injections de moyen de contraste par un cathéter bloqué dans une artère pulmonaire distale. la pression était enregistrée simultanément. Au cours de l'angiographie exécutée avec une technique correcte, le territoire vasculaire obstrué par l'extrémité du cathéter était bien mis en évidence, mais la modification expérimentale de la technique entraîne des changements marqués des images. Le mécanisme de ces changements est examiné.

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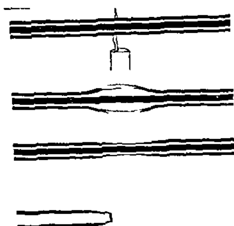


Fig 1 Preparation of catheter tip on a steel wire of the size of the lumen of the tubing

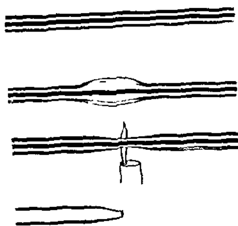


Fig 2 Preparation of a tip smaller than the lumen of the tubing

the roentgendiagnostic technique Furthermore a special form of catheter may be needed for selective examinations (ÖDMAN 1958) Upon being heated in an open flame PTF tubing reacts by swelling slightly and with sudden clearing of its normally whitish opacity, due to the change of the crystalline structure into an amorphous gel At the moment of this reaction the tube can be satisfactorily moulded The catheters are prepared as described in the next four paragraphs

1 The PTF tubing is threaded upon a steel wire of the same size as the lumen After careful heating close to but not quite touching a flame during which the assembly is turned to ensure even heating the material will swell and become clear The tubing is then pulled out in opposite directions on both sides of the heated section (Fig 1) This procedure corresponds with the method developed by ÖDMAN LEDIN for moulding lead containing catheters and results in a rather thin moulded tip of the same calibre as the remainder of the catheter

2 It is sometimes desirable to have an extremely thin wall at the tip of a catheter or cannula It may also be necessary to use a guide wire smaller in diameter than the tubing itself and thus to have the tip portion of the tube smaller in diameter than that of the tubing proper This is often required in the catheterization of tortuous arteriosclerotic vessels which call for as small and flexible a guide wire as possible The tubing should be heated and drawn on a steel wire smaller in diameter than the tubing itself There is some slight tendency to an eccentric deformation of the tip which however, does not essentially hamper its operation (Fig 2) It has sometimes been

FROM THE DEPARTMENT OF ROENTGENOLOGY (DIRECTOR PROF HEINO LAITINEN), KIVELA HOSPITAL, HELSINKI, FINLAND

PREPARATION AND USE OF POLYTETRAFLUORETHYLENE CATHETERS AND CANNULAE IN DIAGNOSTIC RADIOLOGY

by

PEKKA SOILA

Polytetrafluorethylene (PTF), marketed under the brand names of Teflon (Du Pont) and Fluon (Imperial Chemical Industries), is a polymer of carbon and fluorine and is commercially available in powder form and in aqueous dispersion as well as in blocks, sheets and tubing PTF wears well, does not tear readily, and is unaffected by heat up to 200° C or by sudden changes of pressure It is inert to a great number of liquids and gases as well as to living tissue The material has a low coefficient of friction and, in tube form, is suitably rigid

The mechanical characteristics produced by the crystalline structure of PTF make it somewhat difficult to mould by the simple means now practised in the preparation of tubing for roentgendiagnostic purposes In an earlier investigation (BARR and SOILA 1960) it was concluded that mechanical procedures, and to a limited extent the use of heat, might be applied in the process of moulding PTF tubing The favourable characteristics of the material have, however, encouraged another attempt suitably to mould the tubing by means of heat The results of the experiments are now reported

Preparation of tubing

In consideration of the two catheterization methods published by SELDINGER (1953, 1957) and in the light of accumulated experience, it is necessary that the end and tip of the catheter should be moulded to suit the specific needs of

Read in part at the 24th Northern Congress of Medical Radiology Lund Sweden 8—10 June 1961 Submitted for publication 4 September 1961

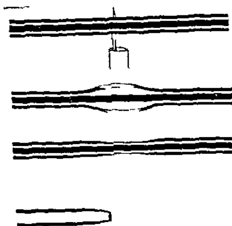


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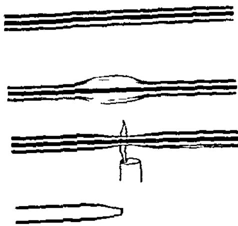


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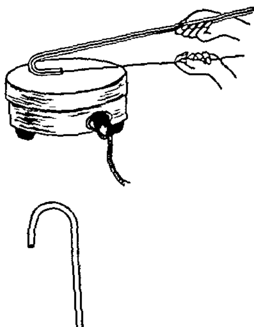


Fig 6 The production of a bend over a boiling plate

The moulding procedures described above require somewhat more practice than that required for polythene tubing

Use of tubing

I PTF catheters may be used in place of polythene catheters the chief advantages being

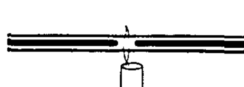
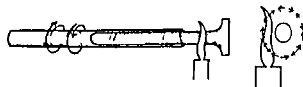
a) the possibility of repeated use of the catheter stock through easy and reliable sterilization of the material

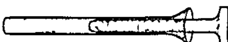
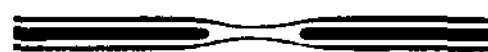
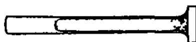
b) the low friction coefficient of the material which makes it less prone to cause clotting of blood

c) the rigidity of the catheter which enables it to be moved backwards and forwards in a vessel even after removal of the guide wire,

d) for the same reason the catheter is less likely to form bends kinks and knots

e) The absorption capacity of the PTF tubing for roentgen rays is low, and not sufficient for the catheter to show up within the great vessels of the body but it may be seen for instance in the neck or limbs (Fig 7)

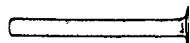


Fig 3 Preparation of a very thin tip on two separate steel wires

Fig 4 Moulding the end with a special device



Fig 5 The instrument for moulding the end

found advisable to draw the tip of the catheter on to two separate pieces of steel wire (Fig 3) This procedure produces a gradually narrowing and very thin wall to the tube It may then be cut off at a suitable point to meet the particular requirements of the procedure

3 Since the moulding of the end of a tube, as suggested by ÖDMAN, did not give entirely satisfactory products, e g the coneshaped end of the catheter tended to assume an eccentric position as well as to slip through the adaptor under high pressure, the following procedure was developed for the moulding of the extremity (Fig 4) The shouldered end of a special steel supporter about one centimeter in length, is placed in the tubing The supporter consists of a handle, a narrowed portion to confine the heat to the extremity and a shouldered end which forms a mould for the tip of the catheter (Fig 5) The end of the tubing is heated and when it becomes transparent and slightly cone shaped it is removed from the heat and quickly pushed against the steel shoulder The tube is then allowed to cool

4 A permanent bend of any desired length and shape may be obtained by placing a long metal wire inside the tube The tube and the wire are warmed over a boiling plate, although not to such a degree as to produce swelling of the material, and the bending performed (Fig 6)

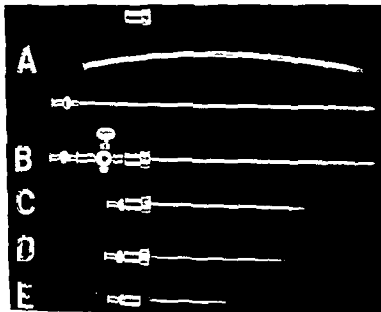


Fig 8 Various types of PTF needle cannulae A — Separate components for the puncture of body cavities and parenchymatous organs B — For the puncture of the femoral artery stop-cock attached to the assembly C — For the puncture of the carotid artery D — For the puncture of the radial artery E — For the puncture of small veins

inevitable spill of blood is considerably reduced as compared with an approach with the Seldinger needle When the guide wire is in place, the cannula may be withdrawn in the customary fashion of the Seldinger technique and replaced by a *catheter* It is usually advisable to make a preliminary puncture of the skin and fibrous tissue before the introduction of the needle cannula combination

IV Selective catheterization through a PTF catheter with a second and smaller PTF catheter may be successfully performed and is especially useful in selective catheterization of the branches of the pulmonary artery and in attempts to catheterize the branches of the coeliac artery The low friction between the two PTF catheters is again of advantage Furthermore the tip of the inner catheter may be made extremely thin to facilitate its progress into the periphery of the vessel

V It is obvious that a catheter with a blind end may be easily introduced into a vessel through a PTF cannula a PTF catheter is to be preferred for this purpose, as the friction between the two tubes is favourably low We

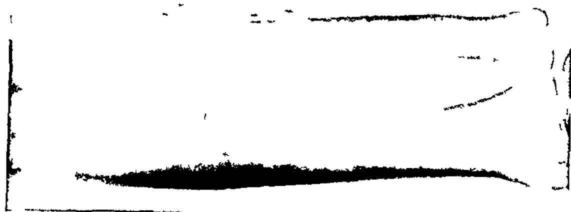


Fig 7 Illustration of absorption capacity for roentgen rays of PTF tubing Cf with appearance of arteriosclerotic vessel

II Short PTF cannulae threaded upon a needle may be used in the examination of regions located in the direction of the blood stream from the point of the puncture As examples may be mentioned angiographic examinations of the upper limb or the brain (Soila 1962) as well as of the lower limbs The introduction of a cannula into the left ventricle of the heart is also practicable Examinations in a retrograde direction of the blood flow are, of course, not possible by this approach A cannula may be introduced into the parenchymatous organs such as the spleen and the liver while the peritoneal and retroperitoneal cavities and the renal pelvis may also be examined by this method (Fig 8)

III A short cannula may be used particularly successfully in place of the barrel of a Seldinger needle (Fig 8b) The method is as follows The needle cannula combination is connected by flexible tubing which should also preferably be of PTF, to a syringe containing saline solution The instrument is first flushed and filled with saline, and as it penetrates the tissues it must be kept continuously clear by repeated flushing with saline When the vessel is perforated and the needle tip seems to lie within the lumen of the vessel, the PTF cannula is carefully pushed into the vessel and the needle and the syringe are removed A continuous bloodflow from the cannula indicates that it is properly placed, should no blood appear, the position of the cannula may be adjusted as its rigidity allows for some manipulation The cannula may be temporarily closed with the help of the adaptor and the stopcock which are carried on the instrument for this purpose (Barr 1959) A guide wire is then introduced through the cannula into the vessel It appears that the

Table

Tests of and injection speed Contrast material Urografin 76% Pressure 10 kg/cm² (= 40 kg cm² in the injection syringe) Gidlund automatic injection device

Dimensions of tube (mm)			Injection time
Inner diam	Wall	Length	
0.8	0.2	1 000	20 sec
0.5	0.15	500	50 sec
0.5	0.15	1 000	2 min 10 sec

Conclusion

The experiments with PTF described have now been in progress for about three years. Few incidents have been encountered in some three hundred cases in which the material has been used. As in catheterizations with similar tubes the tip of the catheter carries certain risks. In direct punctures with the needle cannula a preliminary perforation of the skin and other tough tissues in the path of the intended puncture should be made as previously mentioned. Should a very thin tip be used, the catheter should be fitted on a guide wire or needle. After the tube has been used, the tip should always be examined and moulded anew should evidence of any damage be detected. In a case in which an attempt was made to force contrast medium through a cannula in the femoral artery into the bifurcation of the abdominal aorta and lower limb of the opposite side, the intima of the vessel was torn. This was one of a number of similar observations and is a warning against the use of an unduly high pressure in relation to the size of the vessel to be injected.

Acknowledgements

The experiments were begun during the author's tenure of a James Picker Foundation Research Fellowship at Karolinska Sjukhuset, Stockholm, and continued at Kivela Hospital, Helsinki, with the support of Sigrid Juselius Stiftelse and Reumaliitto-Reumaförbundet. Oy Instrumentarium AB, Helsinki, and Elema Schonander AB, Stockholm, provided facilities for the experiments.

SUMMARY

The characteristics of PTF and certain advantages possessed by catheters and cannulae of this material over those made of polythene, mostly in intravascular catheterization, are described and discussed.

ZUSAMMENFASSUNG

Die karakteristischen Eigenschaften des Polytetrafluorethylen und gewisse Vorteile, welche Katheter und Kanylen aus diesem Material gegenuber Polythenkathetern hauptsachlich bei intravaskularer Katheterisierung besitzen, werden beschrieben und diskutiert.

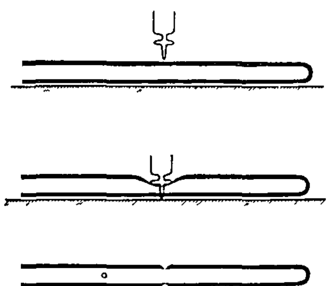


Fig. 9. Fabrication of the side holes with the help of the special instrument used in the preparation of the end.

obtain such catheters from manufacturers, as we have found it difficult to close the ends satisfactorily ourselves. Although the catheters are equipped with a number of side holes, experiments have shown that it is quite feasible to form any number of side holes desired with the tip of the instrument used in moulding the end of the PTF tubes (Fig. 9). The catheter may also be fitted with a guide wire, which facilitates the introduction of the catheter itself and makes fluoroscopic or TV control possible.

The speed of injection for PTF tubings of different dimensions were determined and are given in the Table on next page. It should be pointed out that the pressure in the injection syringe of the Gidlund apparatus is in fact four times that of the reading at the instrument panel. In additional tests of the pressure tolerance, it was found that a tubing of 0.4 mm wall thickness and 1.2 mm diam. did not break until under an actual pressure of 52 kg/cm².

Regarding the behaviour of a bent PTF tubing it may be stated that after about a half hour's catheterization there is some tendency for the material to soften and this may lead to loss of the original form of the bend. This characteristic together with the low absorption of roentgen rays constitute disadvantages as compared with the Ödman-Ledin catheters.

Regarding certain health hazards which have arisen in connection with the moulding of polytetrafluorethylene, the following precautions should be observed: (1) small particles of PTF should not come in contact with a naked flame as fluorine will be released and if inhaled may be dangerous, (2) good ventilation is essential while PTF is being treated with heat, as small amounts of fluorine may be emitted and inhalation must be avoided.

FROM THE DEPARTMENT OF CLINICAL THERAPEUTICS (DIRECTOR PROF B MALAMOS)
SCHOOL OF MEDICINE, UNIVERSITY OF ATHENS GREECE

TUMOUR SIMULATING INTRATHORACIC EXTRAMEDULLARY HEMOPOIESIS

Report of a case

by

B MALAMOS, C PAPAVASILIOU and A AVRAMIDIS

The production of the cellular elements of the blood by the bone marrow may in certain cases be supplemented by foci of extramedullary hemopoiesis located in other tissues Extramedullary hemopoiesis usually takes a nodular pattern the nodules consisting of normoblasts or their precursory cells myeloblasts megacaryocytes or all three elements together The whole process represent a compensatory phenomenon during the course of certain diseases in whic the normal function of the hemopoietic tissue has been disturbed pernicio anemia in periods of relapse macrocytic anemia of hepatic origin osteosclerosi conditions of a neoplastic nature in which the bone marrow is markedly in filtrated by tumour cells (carcinoma Hodgkin s disease lymphoma leucemia osteitis fibrosa cystica erythremia erythroblastosis of the newborn and thala semia (Cooley s anemia)

Ectopic hemopoiesis has been observed in the spleen the liver the hila the kidneys the thymus gland the adrenals the pleurae, the appendix, th retroperitoneal space and the paraspinal region of the thorax

Extramedullary hemopoiesis is usually evident only at microscopy but sometimes encountered as macroscopic tumour like formations Intrathorac extramedullary hemopoiesis in the form of tumour like masses has been me tioned in the literature but to the best of our knowledge, only ten cases ha been reported, in eight of these cases the process was disclosed at autops

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RÉSUMÉ

L'auteur décrit et étudie les caractéristiques du polytétrafluoréthylène, et certains avantages que présentent surtout pour le cathétérisme des vaisseaux, les cathéters et cannulae en polytétrafluoréthylène par rapport à ceux en polythène

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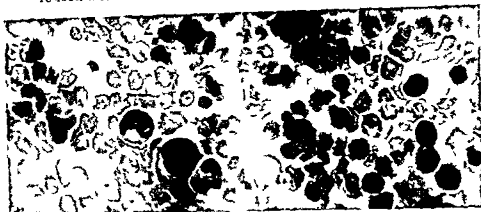


Fig 2 Photomicrograms of smears made from the material obtained by needle aspiration of the intrathoracic masses Erythroblasts and leucocytes at different stages of maturation are seen

There were 9 erythroblasts per 100 white cells in the peripheral blood Serum bilirubin 0 9 mg % direct and 0 48 mg indirect Prothrombin time 51 % Blood urea nitrogen 0 26 mg % blood sugar 0 76 mg % The bone marrow showed marked hyperplasia of the red cell series the white cell series and the megacaryocytes There was no anomaly in the maturation of the red cell series The serum albumin electrophoresis pattern presented a moderate increase in the gamma globulin The hemoglobin electrophoresis pattern revealed 90 % hemoglobin F The sickle cell preparation test was negative Studies with radioactive Cr^{51} revealed that the life span of the red cells was 17 days for Cr^{51}T 1/2 (normal range 27 to 36 days) and the surface counting 2 479 counts/min over the spleen and 2 701 counts/min over the liver with a ratio of 0 89 (normal ratio 1) The red cell radioactive Fe^{59} uptake was 19 8 % (normal range 85 to 100) The iron plasma clearance was 20 minutes for Fe^{59}T 1/2 (normal range 60 to 120 min) The surface counting revealed no increase in the radioactivity over the liver or spleen but a high degree of ineffective hemopoiesis of the bone marrow The findings indicated Cooley s anemia

Roentgen examination Expansion of the ribs with typical trabeculation of Cooley s anemia Soft well defined lobulated masses measuring from 2 to 6 cm in diameter were located posteriorly in the paravertebral gutter from D2 to D10 (Fig 1) There was similar trabeculation in the skull The possibility of intrathoracic extramedullary hemopoiesis was considered and needle aspiration of the masses through the right 5th intercostal space paravertebrally under fluoroscopic control revealed the elements found usually in the bone marrow The material obtained was rich in cell elements and precursors of red cell series and granulocytic white cell series rare plasma cells and reticulocytes were present The red cell elements were more numerous than the white cell elements (220 red cells per 100 white cells) with a significant percentage of proerythroblasts and basophilic erythroblasts (9 % and 39 % respectively) (Fig 2) No megacaryocytes Vim Silverman needle liver biopsy and left axillary lymph node biopsy disclosed extramedullary hemopoiesis Satisfactory healing of the tibial ulcers and some improvement in the hematologic appearances occurred during the patient s stay in hospital.

Discussion

The masses in our case were located paraspinally in the posterior mediastinum and extended from D2 to D10 The roentgen findings were similar to those in KNOBLICH s case In ASK UPMARK s case there was an elongate density



Fig 1 Conventional roentgenogram and tomogram of the chest revealing bilateral well outlined lobulated masses

ASK-UPMARK (1945) reviewed the literature and reported the first case of ectopic hemopoiesis diagnosed by roentgenologic and clinical means His patient suffered from acholuric jaundice KNOBLICH (1960) reported a case of ectopic hemopoiesis in the thorax, found after surgical exploration in a patient in whom the process was detected roentgenologically but was misinterpreted as a neurofibroma The patient had Cooley s anemia which was not diagnosed until the nature of the thoracic tumours was known We recently had a patient who was suffering from Cooley s anemia and in which the diagnosis of intrathoracic extramedullary hemopoiesis was made by roentgenologic means and proved by biopsy

Case report

A male aged 24 was admitted to our department for recurrent ulcers of both ankles At the age of 6 years the patient had had an acute illness of 40 days duration with splenomegaly eruptions of the arms and legs and ulceration of the lower legs this was diagnosed as kala azar A diagnosis of Cooley s anemia was made six years later Since then the patient had been treated for recurrent ulceration of the legs and had received many blood transfusions His general condition had been fair and he had been able to do clerical work

On examination the patient was pale had a muddy yellow skin and appeared younger than his age Mongoloid facies with prominent cheek bones flat frontal bones and hard arched palate The chest was pigeon shaped Weak and soft systolic apical murmur present The liver was slightly enlarged There was general enlargement of the lymph glands particularly in the axillae Chronic ulcers measuring about 6 × 3 cm and 3 × 2 cm were present in the region of the ankles the surrounding skin being atrophic scarred and shiny Hb 8 7 g %, hematocrit 27 % RBC 3 520 000 with anisocytosis poikilocytosis microcytosis target cells hypochromia and anisochromia WBC 7 150 with 60 % polymorphs and 36 % lymphocytes

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measuring 4 5 cm and 7 cm, situated immediately to the right of D7 to D9 At autopsy a smaller mass was found at the same level to the left of the spine and was not evident in the roentgen films, apparently being hidden by the heart

A review of the data of the cases of ectopic hemopoiesis discovered at autopsy revealed that the masses were situated at the costovertebral angle, sometimes bilaterally and were often lobulated These findings correlate well with the roentgen appearances which we have described It is therefore evident that intrathoracic ectopic hemopoiesis follows a constant anatomic pattern which results in similar roentgen appearances of the process ASK UPMARK, trying to explain the location and origin of the masses, postulated a relationship with foci of ectopic hemopoiesis located in the walls of the intercostal veins This would also explain the frequently observed segmental arrangement of the process, as in our case

Well demarcated round, non pulsating masses, located posteriorly in the paravertebral gutter are usually considered to be neurogenic tumours However, KATZ recently stressed the point that, not infrequently, posterior mediastinal masses may also be due to other conditions He mentioned tuberculous abscess, carcinoma, extrapleural cysts, endothelioma, lipoma, carcinoma of the thyroid, intrathoracic meningocele, myxochondroma and benign lymph node hyperplasia Ectopic hemopoiesis should be included in the differential diagnosis which will be clarified by a history of severe anemia, the typical clinical picture and the bone changes

SUMMARY

A case of intrathoracic bone marrow heterotopia simulating tumour masses is described

ZUSAMMENFASSUNG

Ein Fall von intrathorakaler Knochenmarkheterotopie welche Tumormassen simulieren konnte, wird beschrieben

RÉSUMÉ

Description d un cas de hétérotopie intrathoracique de moelle osseuse simulant une masse tumorale

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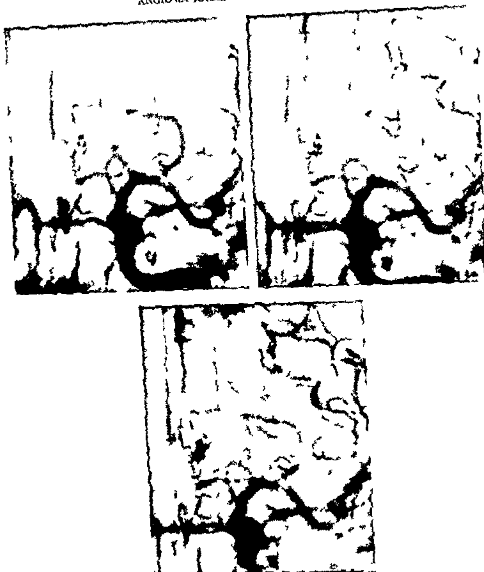


Fig 1 Left carotid angiography (2 films sec) 4 p series Malformation interposed in the course of the inferior part of the pericallosal artery

arteriale and HENSCHEN (1955) stated that all cases that had been *reported* should be accepted with *some reserve* HENSCHEN also held the view that the condition can only *be detected* by making the afferent and efferent passages clearly visible *In classifications of* abnormalities of the cerebral vessels the

FROM THE ROENTGEN DEPARTMENT (DIRECTOR PROF. R. FROWEIN) OF THE MENTAL HOSPITAL OF THE CITY AND UNIVERSITY OF FRANKFURT/MAIN, WEST GERMANY

ANGIOMA RACEMOSUM ARTERIALE DEMONSTRATED BY SERIAL ANGIOGRAPHY

by

HEINZGEORG VOGELSANG

An angioma racemosum arteriale of the cerebral vessels (VIRCHOW) has always aroused some controversy. The condition was described several times by anatomists and pathologists (SIMMONDS, STERZING, LEESER, inter alii) before the era of cerebral angiography, although even then some of the cases cited were questioned. These doubts were emphasized after it could be established that the overwhelming majority of the abnormalities of cerebral vessels are so-called arterio-venous malformations, i. e. that the afflux is effected through arteries and the efflux through venous formations. BERGSTRAND et coll. (1936) came to the conclusion that there was then not sufficient evidence of the existence of a purely arterial angioma. He stated that proof of an angioma racemosum arteriale could not be made by either clinical or pathologic means and the demonstrations of the efferent vessels was only possible by the injection of dyes or radio-opaque material. During the years which followed up to the routine performance of serial angiography, there are occasional reports of an angioma racemosum arteriale having been demonstrated at angiography (REHWALD, CHAVANY et coll. inter alii).

As late as 1947, ASENJO & UIBERALL published a case of an angioma racemosum arteriale in which, however, angiography had not been performed. Today, owing to the experience gained by serial angiography, such reports would appear to be unconvincing. OLIVECRONA (1950) maintained that up to then there had been no unmistakable case of an angioma racemosum

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that the condition it is true, has been postulated theoretically but has so far not been definitely demonstrated We have so far found no report of a single case of an angioma racemosum arteriale reliably verified by angiography This appears to justify the publication of our case

Case report

Male aged 64 was admitted *to hospital* after being found unconscious in the street On examination there were no *signs of any external injury* but some rigidity of the neck was evident and on the following day Babinski s reflex was now and again positive on the two sides The C S F was pale yellow and *contained fresh and lixiviated erythrocytes*

Roentgen examination of the skull revealed *comminuted fractures* of the occipital and parietal bones on the two sides The patient was believed *to have a subarachnoid haemorrhage* and in order to exclude a subdural haematoma *bilateral carotid angiography was performed* an abnormality of the vessels in the region *of the anterior cerebral artery was found* The condition of the patient gradually improved under expectant treatment *and he* was eventually discharged free from signs and symptoms

Whether the subarachnoid haemorrhage resulted from trauma and the abnormality of the left pericallosal artery was discovered by chance or whether — and this seems more likely — there had been a haemorrhage from the abnormal vessel that could have caused a fall with resultant fractures of the skull remained unsolved

Angiography No abnormality of the cerebral vessels was found at right carotid angiography Left carotid angiography revealed an angioma like formation interposed in the course of the left pericallosal artery This part of the examination was supplemented with serial roentgenography at 2 films/sec It was then apparent that the left anterior cerebral artery was of a smaller diameter than the right one The inferior part of the pericallosal artery was divided into numerous tortuous vessels which lay in a coil like formation These vessels then rejoined to form a single artery the further course of which was not abnormal The angioma was particularly well shown in the lateral views and the inosculation of the vessels could be identified by a frayed outline and slight enlargement of the main artery (see Figs 1 and 2)

The serial angiography thus appeared to demonstrate a typical angioma arteriale a convolution of vessels in the course of the artery consisting of numerous small tortuous vessels having an arterial afflux and efflux and lying in the inferior part of the left pericallosal artery

SUMMARY

A case of an angioma *racemosum arteriale* (VIRCHOW) of an anterior cerebral artery demonstrated by serial *angiography is described*

ZUSAMMENFASSUNG

Ein Fall mit Angioma racemosum arterialis *einer Arteria cerebri* anterior welcher durch Serienangiographie dargestellt worden ist wird beschrieben

RÉSUMÉ

Présentation d un cas d angiome racémeux artériel (VIRCHOW) d *une artère cérébrale* antérieure mis en évidence par angiographie en série

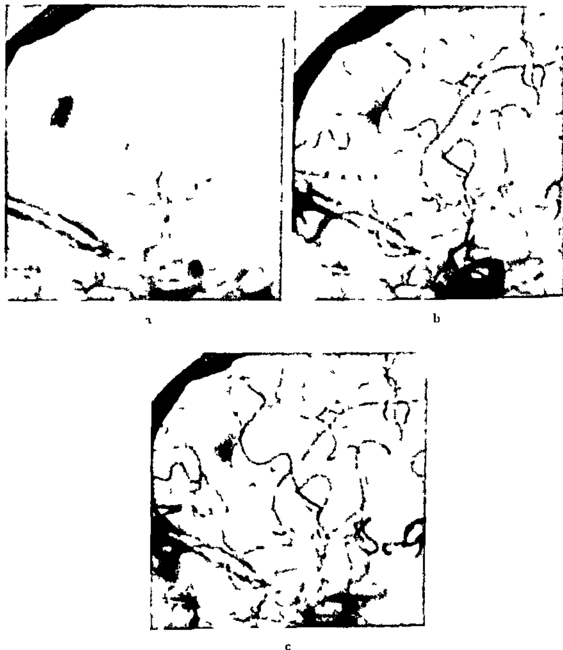


Fig 2 Left carotid angiography (2 films sec) Lateral series a) Transitory filling of right pericallosal artery with first part of left pericallosal artery situated more anteriorly b) and c) Left pericallosal artery with the angioma like formation interposed in its inferior part

angioma racemosum arteriale is usually mentioned (LIMA 1950, GARTNER 1955, KRAYENBUHL & YASARGIL 1957, inter alia), but is described as being 'very rare' ZULCH states in his contribution to the neurosurgical handbook

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INCOMPLETE CONGENITAL SEPTA OF THE DUODENAL BULB

by

KAMILLO FLACHS

Congenital anomalies of the duodenal bulb and the duodenum are not too uncommon and are primarily of importance in the newborn. They very often require surgical intervention to maintain life. Anomalies of a lesser degree are however overlooked as they do not interfere with the physiological processes and are therefore discovered incidentally in later life.

Between December 1954 and August 1960, of all upper gastro-intestinal studies performed, only four revealed incomplete septa of the duodenal bulb. One of the patients expired of other causes and came to autopsy. The autopsy findings of the duodenal bulb confirmed the presence of an incomplete septum, thus supporting the contention that these septa might represent congenital anomalies.

A brief case history of one of these patients is given and is illustrated in Figs. 1 and 2.

A man, aged 60, was admitted to hospital on three separate occasions, the last time on April 22, 1957. Progressive abdominal swelling, anorexia, vomiting and intermittent diarrhea for about one month were the reasons for seeking admission. He had a long history of excessive consumption of alcohol. Hgb on admission was 12.5 g. The roentgenograms of the upper gastro-intestinal tract were normal but for a small incomplete septum of the duodenal bulb (Fig. 1 a and b). The patient expired May 21, 1957, and an autopsy was performed. The duodenal bulb showed an incomplete septum but no scarring or ulcer crater (Fig. 1c and Fig. 2).

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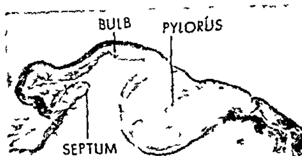


Fig 2 Histologic section from the same patient as in fig 1

ments might not be absorbed at all or absorbed only partially Depending on the degree of developmental disturbances atresias or stenoses of various types may occur complete epithelial diaphragms may be formed, or perforated diaphragms veils or bands may persist (1 2, 3 5) The incomplete septa reported here might be the result of an incomplete absorption of epithelial proliferation during fetal life

A cursory review of recent literature failed to reveal any reference to incomplete septa or veils of the duodenal bulb Nevertheless they are probably more common than expected Many of these changes are probably not recognized and regarded as sequelae of duodenal ulcers (pseudodiverticula) or diverticula of the bulb

At roentgen examinations with barium or double contrast no evidence of ulcer craters or scarring was found in these cases Pseudodiverticula as sequelae of ulcers distort the bulb to such an extent that its normal anatomical outline is completely altered Diverticula by definition fall outside the anatomical contours of the viscus Capping of a diverticulum would not disturb the normal



Fig 3 Similar septa as in fig 1 in two further cases

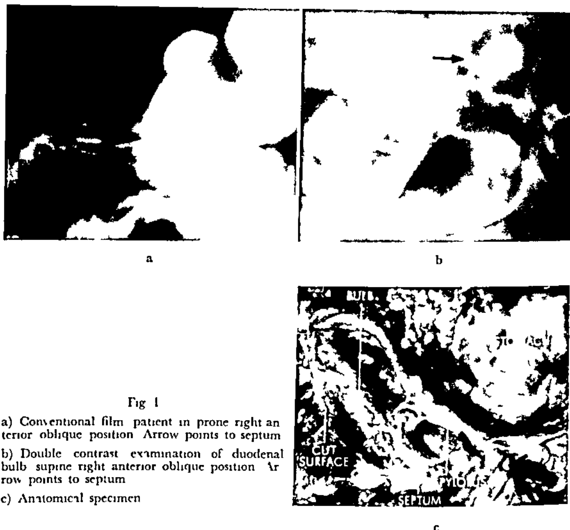


Fig 1

a) Conventional film patient in prone right anterior oblique position Arrow points to septum

b) Double contrast examination of duodenal bulb supine right anterior oblique position Arrow points to septum

c) Anatomical specimen

Similar findings of incomplete septa of the duodenal bulb were demonstrated in three other cases, two of which are illustrated in Fig 3 Due to the similar roentgen appearances we regard it highly probable that the findings are of the same origin even though only one case was confirmed by pathologic anatomical investigation

Discussion

Studies of the embryonal development of the duodenum reveal that in early stages (before five weeks) the intestinal lumen is patent In an embryo of five weeks, the lumen becomes entirely occluded by epithelial proliferation which transforms the gut into a solid cord In an embryo of seven to eight weeks, a vacuolization takes place in the solid cord and finally the lumen is restored (2, 4, 6, 7) In abnormal visceral or vascular development the epithelial ele

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ANGIOGRAPHY IN THE DIAGNOSIS OF TUMORS OF THE URINARY BLADDER

by

ERIK BOIJSEN and JAN NILSSON

It is often difficult to form a clear idea of the nature of tumors of the bladder and to demonstrate whether and to what extent they have grown beyond the bladder wall by clinical and ordinary roentgenologic methods. Since papillary tumors of the urinary tract are richly vascularized, an investigation of the diagnostic value of pelvic angiography in carcinoma of the bladder appeared to be of interest.

The roentgenologic diagnosis of a tumor of the bladder is made by urography and cystography with a positive contrast medium. The latter method will often indicate perivesical infiltration by demonstrating changes between the perivesical fat and the base of the tumor (FRANKSSON & LINDBLOM 1952 and FRANKSSON, LINDBLOM & WHITEHOUSE 1956). This method, however, is not reliable and the changes are often not easy to recognize (DOYLE 1961).

Double contrast roentgenography of the urinary bladder may demonstrate even very small tumors (BARTLEY & HELANDER 1960, DOYLE) but will not show growth extending beyond the bladder wall any better than conventional cystography. Perivesical insufflation with oxygen combined with the injection of positive contrast medium or CO_2 into the bladder will demonstrate infiltration through the wall more satisfactorily than ordinary cystography (TRUC, MARCHAL & PALEIRAC 1951, TRUCCHI 1955, GERARD, DUFOUR & HELENON 1959, PINCELLI & PROSPERI 1959, QUENU & TRUCHOT 1959, BARTLEY & ECKERBOM 1960). Pelvic phlebography has also been tried with a varying degree of success (BAUX 1950, BARTLEY 1958, PYTEL 1959 and others).

From the Roentgendiagnostic Department (Director: Prof. Olle Olsson), University of Lund, Sweden. Submitted for publication 10 November 1961.

anatomical outline of the viscus, while capping of the bulb along the described septa would distort it and the pylorus would appear eccentric as can be readily seen The differentiation of these septa from other pathologic conditions might, therefore, be of some importance

SUMMARY

Four cases of incomplete congenital septa of the duodenal bulb one confirmed by autopsy, and the differential diagnostic aspects are discussed

ZUSAMMENFASSUNG

Vier Fälle mit unvollständigen kongenitalen Septen des Bulbus duodeni, von denen der eine durch Autopsie sichergestellt ist werden besprochen Differentialdiagnostische Aspekte werden diskutiert

RÉSUMÉ

L auteur discute quatre cas de septum congénital incomplet du bulbe duodénal dont un confirmé par autopsie Le diagnostic différentiel est discuté

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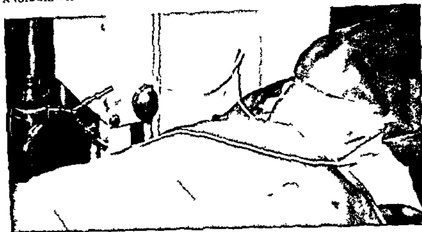


Fig 2 Patient in posit on for bladde angiography A polythe e catheter is inserted through each femo al artery and contrast medium injected s multaneously on both ides through a Y connector

I 21 cases with tumor localized to the mucosa and muscularis (T 1 and T 2) in 2 of these cases the tumor was a pedunculated papilloma without histologic signs of malignancy

II 9 cases in which the tumor grew beyond the vesical wall without being fixed to the pelvic wall (T 3)

III 5 cases with infiltration of the pelvic wall (T 4)

IV One case of adenocarcinoma of the colon with invasion of the fundus of the bladder

V 4 cases in which the lesions found on cystoscopic examination proved to be benign

The best results were obtained by the following method A non opaque polythene catheter (PE 205) is introduced percutaneously into each femoral artery and advanced about 15 *cm* the tip of each catheter lies then in the vicinity of the origin of the internal iliac artery from the common iliac artery and fluoroscopy is unnecessary The two catheters are connected with a Y tube (Fig 2) to permit simultaneous injection of equal amounts of contrast medium on both sides The bladder is then filled with CO after which pressure is applied over the femoral artery The contrast medium usually 30 to 40 ml Urografin 60 or 76 % is then injected

In the first 5 cases of the present investigation medium was injected on one side only and the bladder was not filled with CO, but bilateral injection and insufflation of the bladder gave better definition

When cystoscopy or cystography had shown the tumor to be situated ventrally or dorsally in the bladder the frontal angiogram was supplemented

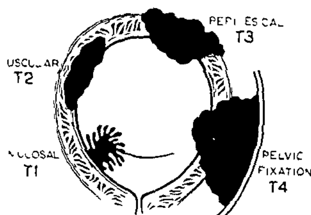


Fig 1 Clinical stages of bladder tumors (after Pugh 1959)

Pelvic angiography is widely used in the diagnosis of tumors of the female genital tract (Borell, Fernström, Lindblom & Westman 1952, Fernström 1955, and others) Despite the clarity with which angiography will enable demonstration of bladder tumors, this method has been applied in less than 10 cases (Berti Riboli, Cerutti, Malchiodi & Reggiani 1957, Reggiani 1957, Macarini, Reggiani & Scursatone 1959)

The writers believe that no attempts have been made to analyse the angiographic appearances of bladder tumors or to ascertain whether angiography can reveal the growth of such tumors through the vesical wall

Material and Methods

Knowledge of the histologic grade and clinical stage of a tumor of the bladder is essential for predicting the prognosis and for choosing the most appropriate line of treatment (Pugh 1957, 1959) The histologic grading given by Dukes (1955), is used at the department of urology (Dr G Jonsson)

Papilloma

Transitional cell carcinoma < Differentiated / Anaplastic > Solid, or papillary, or both

Adenocarcinoma

Squamous cell carcinoma

Wallace's (1956) classification (Fig 1) recognizes 4 stages of local invasion, namely T 1 (mucosal), T 2 (muscular), T 3 (perivesical) and T 4 (pelvic fixation)

Pelvic angiography was performed in 40 cases in which a diagnosis of a probable or definitive tumor of the bladder had been made by urologic procedures The series fell into the following five groups

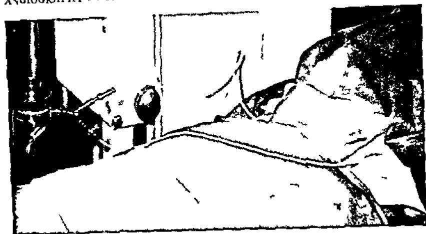


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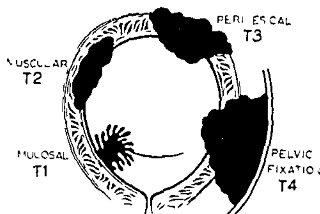


Fig. 1. Clinical stages of bladder tumors (after PUGH 1959).

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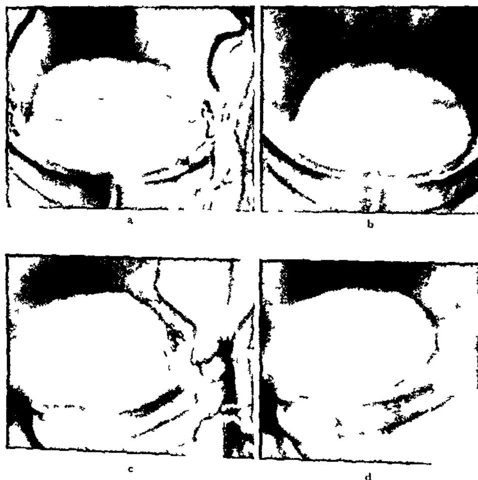


Fig 4 Papilloma 2 cm × 2 cm with atypical cells on left wall of bladder A large vesical artery enters tumor (a and c) and 6 5 sec later (b) veins appear in the pedicle which in the oblique view (d) are seen in an axial projection Profuse accumulation of contrast material and thin vessels within tumor

Results

I Tumors localized to the mucosa submucosa or muscularis of the bladder (T 1 and T 2) In 21 of the 40 cases studied clinical and pathologic examination showed the tumor to be localized to the mucosa (12 cases) or to have infiltrated the submucosa or *muscularis* (9 cases) The findings were confirmed by histologic examination and suprapubic cystotomy in all cases except one of carcinoma of the *prostate with* metastases In 2 cases pathologic examination gave no evidence of malignancy but in both the papilloma was the size of a walnut and pedunculated (Fig 3)

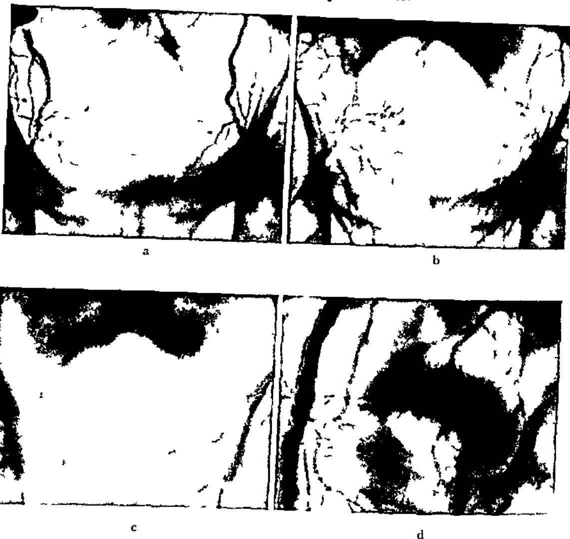


Fig 3 Walnut sized benign papilloma attached to the right side of bladder wall by a small pedicle Pelvic angiography richly vascularized tumor with wide irregular vessels Veins within tumor and pedicle in (c) Oblique (d) widened vessels outside bladder and within the pedicle

with a projection tangential to the base of the tumor For this purpose medium was injected into the artery on the affected side only

The examination was performed with a film changer with two exposures per second for the first 3 to 4 sec and then at longer intervals The first film was exposed at the beginning of the injection and the last 15 sec later

The angiographic characteristics of a tumor of the bladder are the same as those of tumors of the brain or kidney The angiograms were thus studied for any widening or displacement of normally occurring vessels, and for any abnormal vessels Notes were also made of the appearance of the accumulation of contrast medium in the capillaries of the tumor and the time necessary for the medium to pass into the veins of the tumor



Fig 6 Stage T 2 carcinoma about 3 cm × 4 cm and papillomatosis of right half of bladder Inflammatory changes of cystic cystitis in the rest of the bladder Angiography thickened irregular vesical wall and hypervascularity of right half of bladder with tumor vessels No signs of perivesical growth

area indicated by cystoscopy In one case with widespread papillomatosis and stage T 2 carcinoma of the bladder as well as lesions suggesting cystic cystitis, angiography revealed a richly vascularized bladder with slender tumor vessels in the area of the papillomatous changes and irregular pathologic vessels *in that* part of the vesical wall affected by the growth The accumulation of contrast medium in the vesical wall indicated that the wall was markedly *thickened* (Fig 6)

Vessels were demonstrated in all tumors which were 1 cm or more in diameter In some tumors the vessels were slender and of even caliber in others they showed the irregular pattern of malignant tumors of the kidney So-called pathologic vessels were regularly observed in stage T 2 (Figs 7 and 8) but could also be seen in papillomas that showed no histologic signs of malignancy (Fig 3) Characteristic of all growths was the occurrence of tumor vessels not only at the base but also far out into the tumor, usually in its entirety As a rule these vessels were seen 1 5 to 2 5 sec after the beginning of the injection whether the tumor was benign or malignant In these cases no extra vesical tumor vessels were evident in the frontal views or if the tumor was situated dorsally or ventrally in the bladder, in supplementary oblique projections (Fig 8) On the other hand both wide and tortuous vessels were present outside the bladder wall These were however, not tumor vessels but markedly widened preformed vesical arteries supplying the growth (Figs 3 5 and 7)

Unless the tumor was small the main trunk of the vesical arteries was usually wider on the affected side, and then the contrast medium also passed more quickly into the vesical arteries on that side

Accumulation of contrast medium in the tumor was invariably observed and it could readily be demonstrated by comparing the films obtained with





Fig 5 Case 1 a) Large malignant papilloma 5 cm × 5 cm attached to right wall of bladder by pedicle 1 cm in diameter Pedicle not seen at cystoscopy owing to the size of tumor Widened vesical arteries within the pedicle (arrows) from which thin arteries radiate in all directions Compare these vessels with the wide ones seen in a benign papilloma (fig 3) Cystography (c) area of filling defect caused by tumor coinciding with area of vascularized region seen at angiography

In 5 other cases a papilloma was seen, but pathologic examination showed cellular atypia, so that the growths were considered malignant

The pedicle was demonstrated angiographically in all pedunculated tumors (Figs 3 to 5) The pedicle of the tumor was demonstrable by the fact that widened vesical arteries converged to a small area from which slender (Fig 5), or wide and irregular vessels (Fig 3) radiated towards the periphery of the tumor The pedicle of the tumor was the only indication as to whether the tumor was confined to the mucosa The method could thus not differentiate between a papilloma and carcinoma in stage T 1 or T 2

In a few cases the bladder showed not only a large tumor but papillomas of about 5 mm diameter, these could not be demonstrated with certainty by angiography, which revealed only a somewhat richer vascularity in the



F g 8 Case A tumo 3 cm × 4 cm of left posterior part of ves cal wall Angiography r ght oblique revealed a richly vascularized sess le tumor not extending beyond the ves cal wall and sharply outl ned against the p rives cal t ssue (arrows) At cystoscopy a smaller tumor was evident the largest extension of the tumo was within the submucosal and muscular layer of the bladder wall

II Urinary bladder carcinoma penetrating the bladder wall but not invading the pelvic wall (T 3) Of the 9 cases in stage T 3 the bladder was opened in 8 all of which showed perivesical growth In the remaining case the bladder was not opened because biopsy and clinical examination had indicated an in operable papillary solid anaplastic carcinoma invading half the bladder and occluding the left ureter

The local intravesical spread of the tumor as judged by cystoscopy, was usually smaller than that indicated by angiography The number of cases in which palpation suggested growth beyond the bladder wall was strikingly small However only 3 of the 9 cases were palpated under general anaesthesia

Good agreement was however found between the angiographic and oper ative findings In all the nine cases angiography revealed markedly widened vesical arteries on the affected side and irregular pathologic vessels within the tumor (Figs 9 and 10) These tumor vessels arose from vesical arteries and as a rule became demonstrable about 1 5 sec after the start of the injection of contrast medium In all these cases diffusely outlined tumor ve sels were seen outside the vesical wall The veins within and immediately lateral to the tumor generally appeared 3 5 to 6 sec after the beginning of the injection of the medium

The value of pelvic angiography in the diagnosis of perivesical growth is exemplified by the following two cases

Ca e 4 (Fig 9) Male aged 62 in whom cystoscopy revealed a fairly small solid carcinoma adjacent to a diverticulum in the left part of the base of the bladder Clinical examination gave no indication of growth beyond the bladder wall



Fig 7 Case 2 Histologic changes of *cystic cystitis* and malignant changes in lateral part of the right wall At angiography tumor vessels appeared within the right lateral wall and wide veins were filled early

those taken at the beginning of the injection of the medium The accumulation of medium in the tumor was seen best 3 to 6 sec after the start of the injection, and it was most prominent when the passage of the medium into the veins was late On the other hand the veins in the tumor showed up best when they filled early The veins generally became visible 6 to 10 sec after the start of the injection of the contrast medium They were as a rule faint but were always outlined earlier and better on the affected side

A few illustrative cases are described below

Case 1 (Fig 5) Male aged 39 with haematuria Cystoscopy showed a 5 cm × 5 cm tumor in the right half of the bladder owing to its size it was not possible to see where it was attached to the bladder wall

Pelvic angiography Half a second after the beginning of the injection the tumor was seen to be supplied by a wide vesical artery Several wide vessels converged to a relatively small area corresponding to the pedicle of the tumor and then spread in all directions

At operation the tumor was found to be attached to the bladder wall by a pedicle 1 cm in diameter

Case 2 (Fig 7) Male aged 58 with dysuria for 2 years Cystoscopy revealed a lesion in the right lateral wall of the bladder probably a small papillary carcinoma

Pelvic angiography Wide irregular tumor vessels in the right lateral wall of the bladder and passage of the contrast medium into the veins 8 sec after the start of the injection

Operation revealed an area 4 cm × 4 cm in which the mucosa was swollen the consistency of the wall felt slightly increased but not suggestive of carcinoma Histologic examination of the excised area showed cystic cystitis with malignant changes

Case 3 (Fig 8) Male aged 66 Cystoscopy revealed a solid carcinoma in the left part of the anterior wall of the bladder

Pelvic angiography Sessile flat tumor sharply outlined against the perivesical tissue and best seen in the tangential view no tumor vessels evident beyond the bladder wall The patient had been operated upon previously for prostatic hypertrophy and that part of the bladder wall containing the tumor was adherent to the perivesical tissue so that the presence of extra vesical growth if any could not be demonstrated at operation Scar tissue was loosened and resected Pathologic examination gave no evidence of growth of the tumor through the vesical wall



Fig 8 Case 3 A tumor 3 cm × 4 cm of left posterior part of vesical wall Angiography right oblique revealed a richly vascularized sessile tumor not extending beyond the vesical wall and sharply outlined against the perivesical tissue (arrows) At cystoscopy a smaller tumor was evident the largest extension of the tumor was within the submucosal and muscular layer of the bladder wall

II Urinary bladder carcinoma penetrating the bladder wall but not invading the pelvic wall (T 3) Of the 9 cases in stage T 3 the bladder was opened in 8 all of which showed perivesical growth In the remaining case the bladder was not opened because biopsy and clinical examination had indicated an inoperable papillary solid anaplastic carcinoma invading half the bladder and occluding the left ureter

The local intravesical spread of the tumor as judged by cystoscopy was usually smaller than that indicated by angiography The number of cases in which palpation suggested growth beyond the bladder wall was strikingly small However only 3 of the 9 cases were palpated under general anaesthesia

Good agreement was however found between the angiographic and operative findings In all the nine cases angiography revealed markedly widened vesical arteries on the affected side and irregular pathologic vessels within the tumor (Figs 9 and 10) These tumor vessels arose from vesical arteries and as a rule became demonstrable about 1 5 sec after the start of the injection of contrast medium In all these cases diffusely outlined tumor vessels were seen outside the vesical wall The veins within and immediately lateral to the tumor generally appeared 3 5 to 6 sec after the beginning of the injection of the medium

The value of pelvic angiography in the diagnosis of perivesical growth is exemplified by the following two cases

Case 4 (Fig 9) Male aged 62 in whom cystoscopy revealed a fairly small solid carcinoma adjacent to a diverticulum in the left part of the base of the bladder Clinical examination gave no indication of growth beyond the bladder wall



Fig. 9. Case 4. Undifferentiated transitional cell carcinoma, stage T 3. No perivesical infiltration could be felt. At angiography, widened vesical arteries supplying tumor with pathologic vessels. Tumor has grown through the bladder wall. Opacity of whole tumor and large veins within tumor appearing 5.5 sec after start of injection.

Pelvic angiography. Extravesical tumor vessels extending to the pelvic wall. Numerous veins appeared on the affected side as early as 5.5 sec after the start of the injection. A dense accumulation of medium was observed in both the extravesical and intravesical parts of the tumor. The angiographic findings were confirmed at operation, at which it was not possible to remove all the extravesical growth.

Case 5 (Fig. 10). Female aged 68 had been operated upon 8 months previously for a bladder papilloma with cellular atypia but without infiltration of the wall; the growth had been excised and post-operative radiotherapy given. Follow-up examination revealed a palpable fixed lump in the left parametrium due either to fibrosis secondary to radiotherapy or a recurrence.

Pelvic angiography. Tortuous vessels in the region of the base of the bladder and body of the uterus, but the passage of medium into the veins in these regions was not early. Irregular tumor vessels were demonstrated in the left parametrium outside the bladder and the medium passed early into the veins (3.5 sec after the beginning of the injection).

Operation revealed marked fibrosis and induration of the parametrium to the left of the bladder, but it was not possible to say whether the changes were due to radiation fibrosis, to carcinoma, or to both. Biopsy specimens from different parts revealed that the growth had invaded an area in which angiography had demonstrated tumor vessels, but otherwise only radiation fibrosis with numerous dilated vessels was evident.

III. Urinary bladder carcinoma invading pelvic wall (*T-4*). In 4 of the 5 cases in this group operation was not performed because urologic procedures had revealed invasion of the pelvic wall. In one of these 4 cases the pubic bone had also been destroyed by the tumor. In the fifth case invasion of the pelvic wall (symphysis pubis) was also evident upon palpation, but since operation had previously been performed, and roentgen therapy administered for a bladder papilloma with a few atypical cells, fibrosis secondary to operation and radiation therapy could not be excluded with certainty (Fig. 11). Subsequent operation and histologic examination showed, however, that the cancer had invaded the symphysis and floor of the pelvis.

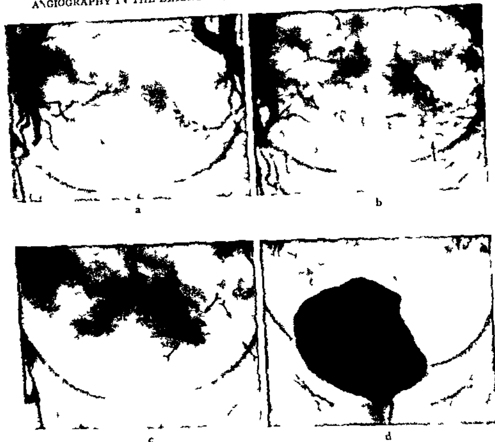


Fig 10 Case 5 Inoperable undifferentiated transitional cell carcinoma stage T 3 following radiologic and surgical treatment of a carcinoma stage T ? At cystoscopy no tumour was evident in bladder Perivesical infiltration palpated but postoperative and postradiotherapeutic reaction could not be excluded At angiography (a b c) tumor vessels to the left of bladder (→) widened uterine and bladder arteries (↠) secondary to radiation treatment Wide veins (↦) appear early in tumor and to its left (c) Cystography (d) bladder deformed but regular walls changes secondary to previous operation and radiation treatment

In all the 5 cases in this group angiography disclosed that the tumor had grown beyond the bladder wall and in all of them the tumor vessels appeared 1 to 2 sec after the beginning of the injection Invasion of the pelvis was also apparent from the observation that not only the vesical arteries but also the obturator and the internal pudendal arteries supplied the tumor

A dense accumulation of contrast medium in the tumor and its vessels were observed in all these 5 cases but in two of them the pathologic tumor vessels were only sparse (Fig 11) The veins also appeared somewhat later in these two tumors which histologically were poorly vascularized

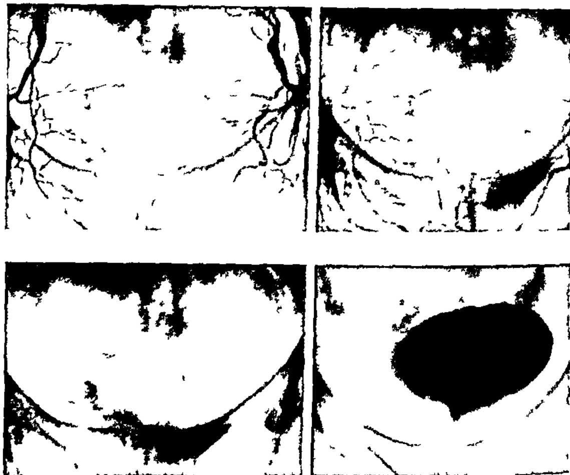
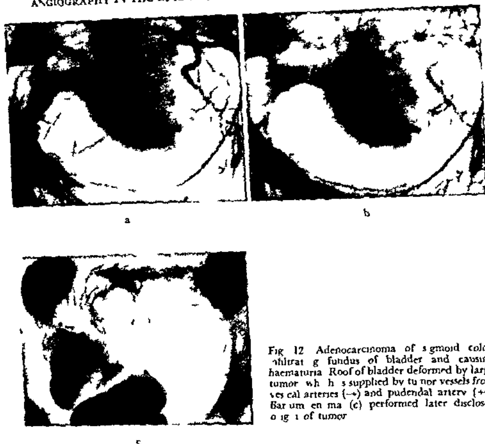


Fig. 11. Recurrent transitional cell carcinoma, stage T 4. Operation showed invasion of symphysis. Sparse tumor vessels of irregular pathologic type; widened branches of obturator artery (arrow) supply the tumor. Dense accumulation of contrast medium within tumor.

IV. Adenocarcinoma. In a woman, aged 70, cystoscopy for haematuria had shown an infiltrating carcinoma of the fundus of the bladder and a palpable lump cranial to the bladder (See Fig. 12). On pelvic angiography, tumor vessels appeared inside and outside the bladder 2 sec after the start of the injection of contrast medium; these arose partly from widened vesical arteries and partly from the internal pudendal artery. It was later found that the tumor originated in the sigmoid colon and had spread to the bladder.

V. Inflammatory lesions originally misconceived cystoscopically as neoplastic. Four cases with a diagnosis on cystoscopy of probable tumor of the bladder were referred to the department of urology. In 2 of the cases the changes were so marked that the surgeon excised that part of the bladder in which the tumor appeared to lie. Histologic examination of the specimen, however, showed only marked inflammatory changes. On control cystoscopy of the third patient



a

b

c

Fig 12 Adenocarcinoma of sigmoid colon infiltrat g fundus of bladder and causing haematuria Roof of bladder deformed by large tumor wh h s supplied by tu nor vessels from ves cal arteries (→) and pudendal artery (↠) Bar um en ma (c) performed later disclosed o ig i of tumor

the base of the bladder disclosed changes characteristic of cystic cystitis which were confirmed by biopsy On control cystoscopy of the fourth patient the lesions originally reported as neoplastic also proved to be in the nature of marked local changes due to cystitis with fibrin deposits On later follow up after appropriate treatment no changes were demonstrable

In these 4 cases angiography revealed a somewhat richer local vascularity in that part of the vesical wall affected by the lesions but only slight or no accumulation of contrast medium in the capillary phase no tumor vessels could be observed The interval between the start of the injection of contrast medium and the appearance of the veins varied but in 3 of the 4 cases it was shorter on the affected side

In one case veins on the affected side appeared in the angiogram much earlier than in the other 3 cases This case is of particular diagnostic interest and is described in detail below



Fig 13 Case 6 Treated previously for carcinoma of bladder Radiation reaction of bladder no recurrence of tumor Pelvic angiography right part of bladder deformed and profusely vascularized only slight accumulation of contrast medium no tumor vessels

Case 6 (Fig 13) Female aged 63 who had been operated upon two years previously for stage T 2 carcinoma of the right lateral wall of the urinary bladder and who had received radiotherapy postoperatively returned because of recurrent haematuria Cystoscopy indicated probable carcinoma of the right wall of the bladder although repeated biopsy produced evidence only of marked chronic cystitis

Pelvic angiography The right half of the bladder was richly vascularized and deformed but no tumor vessels were demonstrated The vesical veins on the right side appeared earlier in the angiogram (about 6 sec after the beginning of the injection) than those on the left side (about 13 sec)

Though neither biopsy nor angiography suggested the presence of a tumor a recurrence was considered probable and exploration carried out operation revealed an area of gross ulceration with marked inflammatory changes

Histologic examination revealed inflammatory changes secondary to radiation therapy

Discussion and Conclusions

We have previously observed that growths of the renal pelvis, which are histologically of the same type as bladder tumors, often have tumor vessels (BOIJSEN & FOLIN 1961)

The present investigation showed that angiography will invariably demonstrate vessels in bladder tumors that are 1 cm or more in diameter The angiographic appearance of such tumors should not be confused with that of hypervascularization in chronic inflammation with abundant granulation tissue (LAGERGREN, LINDBOM & SODERBERG 1958) In both cases the contrast medium passes early into the veins On the other hand no irregular tumor vessels will be evident in the presence of chronic inflammation only, nor is it likely that all the fine tumor vessels sometimes demonstrable in highly differentiated papillary carcinoma will be seen MATTSSON (1955) found that vessels less than 0 3 mm in diameter will not be visible in pelvic angiograms

It is therefore impossible to discern the vessels in inflammatory granulation tissue for according to LAGERGREN et coll their caliber is less than 0 3 mm and the width of the vessels in a papilloma less than 1 cm in diameter is probably of the same order This explains the findings in 4 cases of probable tumor due to a severe local chronic cystitis, the area affected was to a certain degree hypervascularized with slightly widened vesical arteries and, in 2 of the 4 cases faint accumulations of contrast medium but no vessels within the actual granulation tissue were present

Bladder tumors are nearly always accompanied by chronic inflammation which though sometimes marked is localized to the base of the tumor and the vesical wall but does not involve the stroma of the growth Angiographic examinations proved that the tumor vessels occur not only in the bladder wall but particularly in the stroma of the tumor and although widened vessels are not always evident in the entire tumor, the latter invariably shows an accumulation of contrast medium indicating dense vascularity

In an attempt to find further support for the assumption that the angiographic changes observed were not due to chronic inflammation *alone* the diagnosis in the first 17 cases of vesical tumor studied angiographically was checked histologically (N Johnsson) Of 13 cases belonging to groups T 1 to T 3 numerous tumor vessels were seen in 11, in the remaining 2 cases in which the vascularity was regarded as sparse, the *specimens sent for histologic examination* consisted of superficial tissue fragments too small to estimate the vascularity Two of the stage T 4 cases showed only sparse vessels Pelvic angiography in these 2 cases likewise revealed only few but nevertheless distinct vessels

All of the specimens checked histologically displayed a varying *degree of* inflammatory reaction this reaction was most marked at the base of the tumor and in that part of the vesical wall around the tumor *while the vessels* which were often widened *were seen* at the bases of the tumors as well as in their stroma

It may thus be concluded that the vessels *observed* in the tumor were not due to inflammatory granulation tissue *Widened vessels are also* occasionally seen in radiation fibrosis but they *then have* a more regular appearance though they may sometimes be *tortuous* In addition in such cases the contrast medium does *not* pass so quickly into the veins as it does in the *presence of* a tumor

It is thus clear that *it is* possible by means of angiography to diagnose bladder tumors and to *distinguish* between inflammatory and neoplastic changes in cases *when* this cannot be done at *cystoscopy* On the other hand a decision as to whether a *papilloma* is benign or malignant can never be made and a demonstration as to whether the tumor has invaded the mucosa only, or the submucosa and *the musculans* is again outside the scope *of the* method



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All of the specimens checked histologically displayed a varying degree of inflammatory reaction this reaction was most marked at the base of the tumor and in that part of the vesical wall around the tumor, while the vessels which were often widened were seen at the bases of the tumors as well as in their stroma

It may thus be concluded that the vessels observed in the tumor were not due to inflammatory granulation tissue Widened vessels are also occasionally seen in radiation fibrosis but they then have a more regular appearance though they may sometimes be tortuous In addition in such cases the contrast medium does not pass so quickly into the veins as it does in the presence of a tumor

It is thus clear that it is possible by means of angiography to diagnose bladder tumors and to distinguish between inflammatory and neoplastic changes in cases when this cannot be done at cystoscopy On the other hand a decision as to whether a papilloma is benign or malignant can never be made and a demonstration as to whether the tumor has invaded the mucosa only or the submucosa and the muscularis is again outside the scope of the method

It is, however, much more important to know whether the tumor has infiltrated the perivesical fat, and in this respect angiography has proved superior to other examination methods In all the 14 cases in which the tumor had grown beyond the vesical wall the extravesical growth was demonstrated at angiography Clinically, it is often difficult to decide whether the tumor has grown through the wall of the bladder, as is evident from the cases described above Palpation under general anaesthesia will not always show the local extent of a tumor (NILSON 1958) Cystography alone or combined with perivesical oxygen insufflation has given encouraging results, but if the tumor is located at the base of the bladder or behind the symphysis pubis, its extent cannot be demonstrated by these methods Perivesical oxygen insufflation appears to involve certain risks if the actual tumor is insufflated (BARTLEY & ECKERBOM 1960) In recurrence of a bladder tumor operated upon previously or treated radiologically and with scar tissue and radiation fibrosis, it is not possible by palpation or cystography combined with perivesical oxygen insufflation to decide whether perivesical infiltration is present or not, surgical exploration will not always decide this point either In such cases angiography will afford a clear picture of the situation (Case 3, for example)

Perivesical infiltration is characterized by diffusely outlined tumor vessels outside the wall of the bladder, a dense accumulation of contrast medium in the tumor, and a much earlier passage of the medium into the veins (shunting) than when the tumor involves only the bladder wall There is generally no displacement of the arteries in the lesser pelvis

It seems that if the tumor is supplied not only by vesical arteries but also by symphysial branches from the obturator artery or internal pudendal artery, the tumor has probably invaded the pelvic wall This was observed in all 5 cases belonging to stage T 4

The angiographic pattern of the lesser pelvis will be the subject of a future paper, suffice it here to mention that in the presence of a tumor, vesical arteries on the affected side are widened and that the contrast medium passes more quickly into the vesical arteries on that side It is thus essential to compare the vessels on both sides This holds both for the arterial and venous phases Distinct differences may be seen between the healthy and the affected side during the venous phase The veins on the healthy side are generally faintly filled 13 to 15 sec after the start of the injection of contrast medium If the tumors are small and situated within the bladder, the veins, though faint, will be visible about 6 to 10 sec after beginning of the injection, but they will be more distinct and appear earlier than on the healthy side If the tumor has grown beyond the bladder wall, veins on the affected side will appear 3 to 6 sec after the start of the injection In 3 of the 4 cases with local, intense chronic inflammation the veins became visible earlier than normally (9 and 10 sec, respectively, after the beginning of the injection)

It is clear from the investigation that pelvic angiography is a valuable

supplementary method not only in the diagnosis of a tumor of the bladder, but above all in demonstrating its local spread this latter being of importance for deciding the most appropriate type of treatment and for assessing the prognosis in a given case Angiography is particularly valuable in the examination of cases which have on some previous occasion received surgical or radiation therapy and in which it is difficult to decide whether any changes observed should be interpreted as due to radiation fibrosis or recurrence The method may also be used for assessing the effect of surgical or radiologic treatment

SUMMARY

The vascular supply of the bladder was studied by angiography in 40 cases in which cystoscopy had indicated probable or definite malignancy It was found possible to diagnose growths of the bladder and to demonstrate their local spread into the lesser pelvis by means of the method

ZUSAMMENFASSUNG

Die Blutversorgung der Harnblase ist an Hand von Angiographien in 40 Fallen studiert worden bei denen die Cystoskopie wahrsch inliche oder sichere Malignitat zeigte Man fand dass es mit dieser Methode moglich ist Tumoren der Harnblase und ihre lokale Ausbreitung im kleinen Becken zu diagnostizieren

RÉSUMÉ

Les auteurs ont étudié la vascularisation de la vessie par angiographie dans 40 cas ou la cystoscopie avait montré des signes probables ou certains de malignité Ils ont constaté qu il est possible de diagnostiquer les tumeurs de la vessie et de mettre en évidence leur extension locale dans le petit bassin par cette méthode

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PHAEOCHROMOCYTOMA DEMONSTRATED BY AORTOGRAPHY

Report of two cases

by

LARS R HOLSTI

Recent literature has laid stress on the diagnostic importance of aortography in tumours of suprarenal origin (EDSMAN 1957 AHLBÄCK 1958 GOODWIN 1961) Few cases however of phaeochromocytoma established by this method have been verified histologically a survey of the literature yielded only 15 cases (DAHL IVERSEN 1957, EDSMAN 1957, SUSSE & RADKE 1957 ELFVIN 1959, GOODWIN 1961 PYLE 1961) in 2 of which the growths were bilateral (DAHL IVERSEN PYLE) Two further cases of this rare condition are now reported

Case reports

Case 1 Male aged 17 with four months history of right sided blurring of vision and headaches a blood pressure of 170/120 and hypertensive changes of grade III—IV in the ocular fundi The sight of the left eye had also deteriorated considerably and the patient was no longer able to read Ocular pressure 50 bilaterally The case had first been treated as one of glaucoma

On examination the blood pressure was found to have risen to 200/160 and electrocardiography demonstrated signs of slight left ventricular cardiac hypertrophy There was increased excretion of urinary catecholamines (400—1 200 μg in 24 hours) and a typical rapid fall in blood pressure from 200/155 to 140/60 occurred following the intravenous injection of regitine Good renal function urography normal At retroperitoneal pneumography a plum sized mass was evident in the region of the left suprarenal gland

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a b

Fig 2 Phaeochromocytoma in left renal hilum arterial phase (a) capillary phase (b)

Case 2 Male aged 18 with a ten months history of periodical tachycardia sweating vertigo and fatigue He had been examined on three occasions and found to have a blood pressure ranging from 140/100 to 180/110 Urography retroperitoneal pneumography the histamine test and the urinary electrolyte values were all normal There was evidence however of an increased excretion of urinary catecholamines (165—750 µg in 24 hours)

At aortography the same precautionary measures were taken as in the first case but neither catheterization nor the injection of contrast medium (10 ml Urografin 60) with a pressure syringe caused elevation of blood pressure No regitine was therefor administered The right suprarenal gland appeared to be regular during the nephrographic phase No increase in the density of the contrast medium was evident at the normal sit of the left suprarenal gland but an opacity due to contrast medium appeared close to the hilum of the left kidney in the nephrographic phase this was misinterpreted as an early venous phas

At operation (Docent M Turunen) 5 days later the left suprarenal gland was found to be close to the hilum of the kidney A large cherry sized tumour was attached to the medial margin of the suprarenal gland and together with part of the gland was resected The tumour was found histologically to be a typical phaeochromocytoma At re appraisal of the arteriograms after operation a cluster of pathologic vessels obviously arising from the middle main renal artery was evident in the region of the hilum of the left kidney (Fig 2a) The opacity mentioned (Fig 2b) was seen at the same site in the nephrographic phase The change was thus caused by the phaeochromocytoma

Discussion

The aortograms of both of the cases were characterised by rich vascularity and tumour vessels features which are typical of the majority of the other

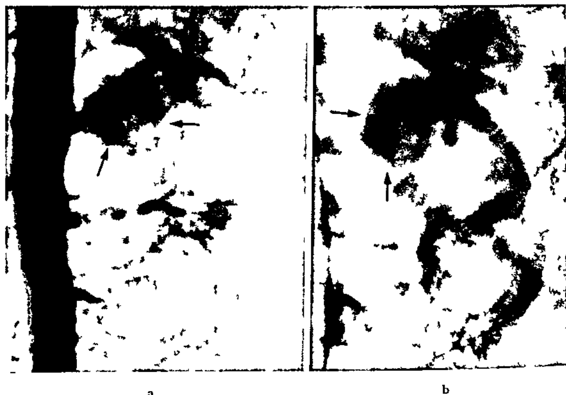


Fig 1 Case 1 Aortograms a) Arterial phase tumor vessels from inferior suprarenal artery b) Capillary phase contrast filling of phaeochromocytoma above hilum of kidney

Aortography was performed with the catheter tip at the level of Th 12 As the catheter was being inserted the systolic blood pressure rose from 180 to 320 and the patient complained of increasingly severe headache The anesthetist who was present throughout the examination, injected 5 mg regitine via a needle inserted in the cubital vein before the examination was started This produced a rapid fall in the systolic blood pressure to 160 and during the injection of the contrast medium (40 ml Urografin 60 %) for which a pressure syringe was used the blood pressure remained stable The renal vessels appeared normal During the arterial phase an artery arising from the left renal artery was seen to run upwards to the upper pole of the kidney where it divided into two smaller branches and these in turn into numerous small tumor vessels (Fig 1a) No arteries arising from the aorta were seen running to the suprarenal region A tumor like mass measuring 3 × 4 cm and lying close to the upper pole of the kidney became filled during the nephrographic phase (Fig 1b) it was completely homogeneous at the end of the examination Faint normal vasculature was seen on the right side

At operation (Prof V Seiro) 3 days later a plum sized solid smooth walled and bluish tumour arising from the median aspect of the left suprarenal gland was found Suprarenalectomy was performed and the tumour was removed The cut surface of the tumour was light grey in colour and displayed numerous petechiae The histologic appearances were typical of a benign phaeochromocytoma The systolic blood pressure which was 190 at the beginning of the operation rose temporarily to 240 and fell immediately after the excision of the tumour to 105 The urinary catechol excretion decreased after the operation to 40 μg in 24 hours the blood pressure was stabilised at 130/90 and the patient s sight improved so that he was again able to read

ZUSAMMENFASSUNG

Mit perkutaner femoraler Aortographie sind 2 Falle von Phaeochromocytom nachgewiesen worden Die Einfuhrung des Katheters verursachte in einem der Falle eine Blutdrucksteigerung diese wurde mit unmittelbarer intravenoser Injektion von Regitine behandelt Das Risiko einer Aortographie bei Phaeochromocytomen und die notwendigen Vorsichtsmassnahmen werden kurz besprochen

RÉSUMÉ

Deux cas de phéochromocytome ont été diagnostiqués par aortographie fémorale percutanée L introduction du cathéter a provoqué une crise d hypertension dans un cas traitée par injection intraveineuse immédiate de régitine L auteur examine brièvement les dangers de l aortographie dans le phéochromocytome et les précautions nécessaires

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SALTZ N J LUTTWAK E M SCHWARTZ A and GOLDBERG G M Danger of aortography in localization of phaeochromocytoma Ann Surg 144 (1956) 118

SUSSE H J und RADKE H Nachweis und Lokalisierung von Nebennierentumoren mittels Aortographie Fortschr Rontgenstr 86 (1957) 599

cases reported in the literature. The two avascular phaeochromocytomas described by EDSMAN (1957) are more uncommon.

A considerable elevation of the blood pressure occurred during the catheterization in the first case. Precautions had been taken, however, and the immediate injection of regitine rapidly lowered the blood pressure which then remained stable during the actual examination. The same precautions were observed in the second case, but the blood pressure did not change during the procedure. Both AMUNDSEN et coll. (1956) and EDSMAN (1957) have reported a hypertensive attack during aortography but, as in our Case 1, no more serious sequelae occurred. On the other hand, the literature describes two hypertensive crises after translumbar aortography, both of which terminated fatally (KOONCE et coll. 1952, SALTZ et coll. 1956). In both these cases autopsy revealed a hemorrhage in the retroperitoneal space. SALTZ et coll. considered adrenaline shock in their case to have been the cause of death. A third of all active phaeochromocytomas secrete adrenaline as well as noradrenaline (VON EULER & STROM 1957). It is known that patients with a phaeochromocytoma may die after a minor operative procedure (ARANOW 1950). Aortography should therefore be performed in these patients in such a way that they are subjected to as little stress as possible and irritation of the active phaeochromocytoma avoided. Translumbar aortography should give place to catheterization, but not to selective renal angiography. The patient may be examined under narcosis, as was done by PYLE, regitine may be administered prophylactically, as by GOODWIN, or regitine may be kept in readiness for injection as by the present author. A precautionary measure that has been found useful is for the anesthetist to be present during the examination to control the blood pressure and general condition of the patient. In addition GOODWIN injected procaine intra-aortally to avoid spasms. The patient must be sedated. The forestalling of complications during the examination is all important and must always be given careful thought and consideration.

Addendum

Since completion of the manuscript the author has had the opportunity of studying three further cases in which phaeochromocytoma was localised preoperatively by aortography. One of the cases was malignant.

SUMMARY

Two cases of phaeochromocytoma were demonstrated by percutaneous femoral aortography. Insertion of the catheter caused a hypertensive attack in one of the cases and was managed by the immediate intravenous injection of regitine. The risks of aortography in phaeochromocytoma and the necessary precautionary measures are briefly discussed.

ZUSAMMENFASSUNG

Mit perkutaner femoraler Aortographie sind 2 Fälle von Phaeochromocytom nachgewiesen worden Die Einführung des Katheters verursachte in einem der Fälle eine Blutdrucksteigerung diese wurde mit unmittelbarer intravenöser Injektion von Regitine behandelt Das Risiko einer Aortographie bei Phaeochromocytomen und die notwendigen Vorsichtsmassnahmen werden kurz besprochen

RÉSUMÉ

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FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (DIRECTOR PROF SOLVE WELIN),
MALMO ALLMANNA SJUKHUS, MALMO, SWEDEN

SERIAL PHLEBOGRAPHY OF THE NORMAL LOWER LEG DURING MUSCULAR CONTRACTION AND RELAXATION

by

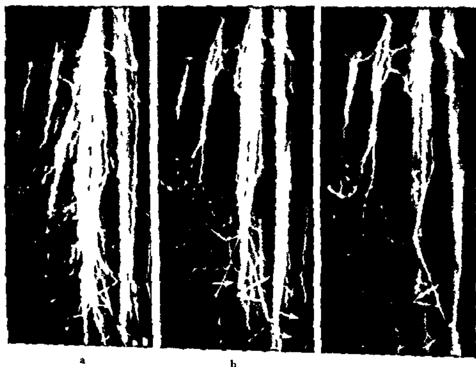
TORSTEN ALMEN and GORAN NYLANDER

It has long been known that compression of the veins by the muscles is an important factor in assisting the return of blood to the heart, and particularly the return of blood from the lower leg and the foot (LE DENTU 1868, BRAUNE 1889, MC PHEETERS et coll 1932, BARCROFT & DORNHORST 1948, BARCROFT & SWAN 1953). Our notions of the actual mechanism by which muscular contraction brings about this effect are however still vague. The wide use of phlebography in the investigation of circulatory diseases of the leg increases the necessity of detailed knowledge of the flow characteristics of the blood in the normal leg in diagnostic radiology. It was in an attempt to fill this gap that the present investigation was started, the results are described below.

Material and methods. The material consisted of 13 apparently healthy volunteers (3 males and 10 females) aged 22 to 70. Three subjects were examined bilaterally.

With the subject sitting, the lower leg vertical and the foot resting flat on a support before a cut film changer 40 ml Urografin 60 % were injected into a dorsal vein (injection time 15 to 60 sec) of the relaxed foot. Just before conclusion of the injection the film changer was started, and a few seconds later the patient was instructed to raise and lower the heel alternately with maximum

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a b c

d e

Fig 1 Serial phlebography during act of contraction (a)—(c) and act of relaxation (d)—(f) Film speed 2/sec

a) Resting Muscle veins deep and superficial veins well filled Valves in popliteal vein open

b) Early contraction Muscular and deep veins partly compressed At → valves closed in distal part of deep veins

c) Full contraction The soleus veins empty Deep veins markedly compressed

d) Early relaxation Contrast medium from deep vein enters the muscle veins Increasing width of deep veins At→ valves closed in proximal part of deep veins Valves in distal part of deep veins open

e) The muscle veins well filled Normal width of deep veins

contraction of the calf muscles He was requested to relax the muscles for a couple of seconds between each pair of movements

Films were exposed at the rate of 2 to 3 per sec, 70—80 kV, 100 mA, 0 06 sec, FFD 100 cm

Observations

During rest (muscles relaxed and entire foot resting on support) A filling was obtained of the deep and superficial veins as well as of the perforator veins in the lower two thirds of the leg In the beginning of the examination the filling of the muscle veins was not complete, the degree of incompleteness varying from one subject to another

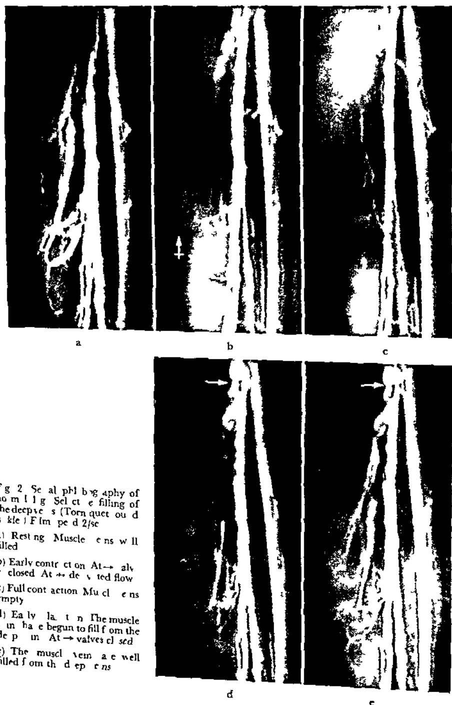
During act of contraction (time necessary for relaxed muscle to contract completely during raising of heel) During this movement the perforator veins between the muscle veins and superficial veins closed, the valves in the popliteal vein were open The muscle veins were markedly compressed and their contents were spurted with great force into the deep veins, simultaneously the valves of the deep veins and the perforator veins in the distal part of the leg closed The deep veins were then compressed and their contents forced into the popliteal vein

Muscles in state of contraction (heel raised from support and M soleus contracted) The muscle veins were completely and the deep veins markedly compressed The valves of the deep veins in the lower third of the leg were closed There was no demonstrable flow of contrast medium in the deep veins Contrast medium from the lower part of the leg gradually flowed up through the superficial veins

During act of relaxation of muscles (time necessary for contracted muscles to relax completely during lowering of heel onto support)

The valves in the distal segment of the popliteal vein closed The valves of the deep veins in the lower third of the leg opened The valves in the superficial veins above the level of the origins of the perforator veins closed Contrast medium flowed from the peripheral, deep and superficial veins of the foot and lower third of the leg to refill the deep veins, whence large amounts of contrast medium flowed into the muscle veins

Muscles relaxed The phlebogram of the leg with the muscles relaxed was the same as that at the beginning of the examination with the exception that the muscle veins and the popliteal vein were now well filled with contrast medium



F g 2 Se al phl b g aphy of no m l l g Sel ct e filling of the deep ve s (Torn quet ou d a kle) F lm pe d 2/sc

a) Rest ng Muscle e ns w ll filled

b) Early contr ct on At → alv e closed At ↔ de v ted flow

c) Full cont action Mu cl e ns empty

d) Ea ly la t n The muscle v in ha e begun to fill f om the de p in At → valves cl *sed*

e) The muscl vein a e well filled f om th d ep e *ns*

contraction of the calf muscles. He was requested to relax the muscles for a couple of seconds between each pair of movements.

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The valves in the distal segment of the popliteal vein closed. The valves of the deep veins in the lower third of the leg opened. The valves in the superficial veins above the level of the origins of the perforator veins closed. Contrast medium flowed from the peripheral, deep and superficial veins of the foot and lower third of the leg to refill the deep veins, whence large amounts of contrast medium flowed into the muscle veins.

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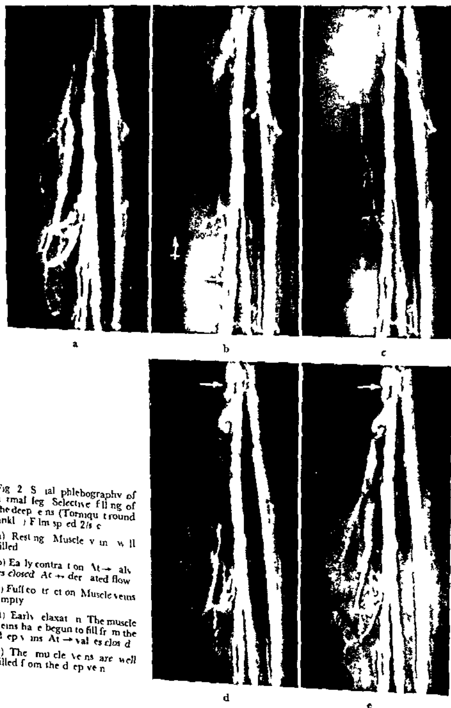


Fig 2 Serial phlebography of normal leg Selective filling of the deep veins (Tourniquet round ankle) Film speed 2/sec

a) Resting Muscle veins well filled

b) Early contraction At → valves closed At → der ated flow

c) Full contraction Muscle veins empty

d) Early relaxation The muscle veins have begun to fill from the deep veins At → valves closed

e) The muscle veins are well filled from the deep vein

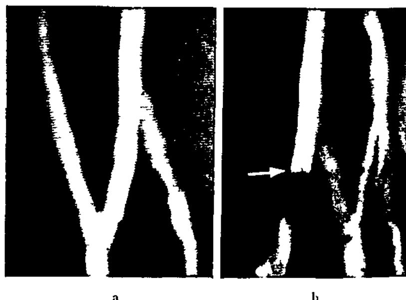


Fig 3 Valve in the lesser saphenous vein immediately above the origin of a perforator vein a) Muscle contraction — the valve is open — derivation b) Muscle relaxation — the valve is closed (→) — suction

Discussion

Examination of the series of films taken in the positions described showed that during exercise the blood in the lower leg veins flows in a jerky manner, each jerk corresponding to a contraction or relaxation of the muscles The analysis also showed that when the muscles are in a state of contraction or relaxation the venous flow is very slow

During rest POLLACK & WOOD (1949) measured the pressure in the great saphenous vein at the level of the ankle and found it to correspond to the hydrostatic pressure from the level of measurement to the level of the right atrium GREITZ (1955) has shown that in resting subjects when the lower leg is vertical, contrast medium can pass from the deep to the superficial venous system via the perforator veins Their observation supports our opinion that during rest the pressure in all parts of the lower leg veins corresponds to the hydrostatic pressure to the level of the right atrium and that the venous flow passes through both the deep and the superficial veins This is also borne out by our observation that on injection of contrast medium into a dorsal vein of the relaxed resting foot, the medium spread among the deep and superficial veins, according to the law of vessels in open communication, with the upper level of the contrast medium at the same level in the deep veins as in the superficial veins

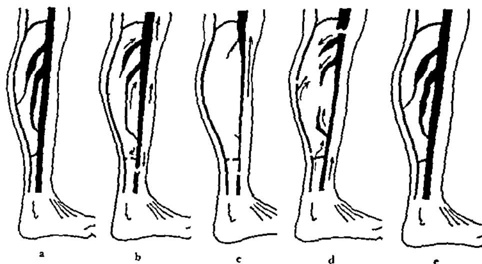


Fig 4 Drawing illustrating the series of events during muscle contraction and relaxation The arrows indicate the blood flow a) Resting b) Early contraction c) Full contraction d) Relaxation e) Resting

Muscle contraction In contradistinction to what was seen with the muscles relaxed contraction of the muscles caused a rapid flow of the blood The sequence of events during contraction was as follows In the initial stage of muscle contraction the muscle veins contain much blood (According to BEST & TAYLOR 1961 In animal experiments in which skeletal muscle is perfused with blood under a constant pressure, the arterial inflow decreases and venous outflow increases during muscular shortening) The perforator veins between the muscle veins and the superficial veins are compressed by the surrounding muscle and thereby closed The muscle veins are likewise compressed by the muscles and their contents are forced into the deep veins of the lower leg These veins which are situated between the two layers of muscles of the calf, are compressed to a varying extent according to the degree of contraction of one or both groups of muscles The pressure increase produced in the deep veins (vis a latere increases) closes the valves in the distal part of the deep veins and in the perforator veins between the deep and the superficial venous systems The blood in the deep veins is then pressed up into the popliteal vein The muscle veins empty rapidly an observation also mentioned by GULLMO (1957)

POLLACK & WOOD who also measured the pressure in the great saphenous vein during muscular exercise found a short initial rise in pressure in the superficial venous system which in our opinion corresponds to the increase in pressure in the deep veins transmitted to the superficial veins before closure of the

valves in the perforator veins The contraction of the muscle takes about a second or less This is followed by the phase during which the subject sits with the calf muscles contracted

Muscles contracted During this period the muscle veins are almost completely and the deep veins markedly compressed The valves in the distal parts of the deep veins are still closed The blood from the peripheral region cannot pass up through the deep veins but is seen to flow proximally through the superficial venous system Our investigation appears to justify LE DENTU's assumption of 'canaux de dérivation'

Muscle relaxation On relaxation of the muscles the latter no longer compress the muscle veins, deep veins and perforator veins passing through the muscles The pressure prevalent in these veins therefore falls and blood flows in towards the deep veins and muscle veins Blood in the popliteal vein flows in a retrograde direction, closes the valves in this vein, and thereby prevents a further retrograde flow of blood to the deep veins in the lower leg These deep veins and the muscle veins are then rapidly refilled partly from the deep distal veins whose valves open, and partly from the superficial venous system via perforators We have seen sections of the superficial venous system to empty completely when their contents were sucked into the deep veins and muscle veins on relaxation of the muscle

Such suction explains the marked fall in pressure which POLLACK & WOOD found in the distal part of the great saphenous vein on relaxation of the muscle They found in normal subjects in the erect position that the pressure distally in this vessel fell from 90 to 30 mm Hg on relaxation of the calf muscles This relaxation which required only half a second was sufficient to cause this fall in pressure It then took about 25 seconds before the pressure in the distal part of the great saphenous vein recovered its initial value

The fact that the muscle veins become well filled with contrast medium on relaxation of the muscle shows that they are filled mainly from the deep veins, for the capillaries contain no contrast medium Thus the blood coming from the capillary bed of the muscles does not represent the whole portion of the blood in the muscle veins (On relaxation of the muscle the venous outflow from the muscle diminishes at the same time as the arterial inflow increases — BEST & TAYLOR 1961)

On relaxation of the muscles the deep veins refill rapidly (between 0 5 and 1 5 sec) On subsequent contraction they are rapidly emptied again, but if relaxation is followed by a period of rest the contrast medium flows only slowly upwards and then the only propelling force appears to be the pressure from the arterial side *via capillaries, vis a tergo*

The muscle veins thus serve two purposes to drain the muscles and to pump the blood from the periphery towards the heart It would appear that

the importance of this pumping effect of the muscle veins has not previously been recognized to its full extent

The function of these veins is illustrated schematically in Fig 4 During muscle contraction substantial amounts of blood are expelled from the muscle veins in a proximal direction and during relaxation large amounts of blood are sucked up from the distal veins into muscle veins

The compression of the deep veins and its significance to the venous flow from the lower leg has already been stressed This effect together with that of the muscle veins represents the total pumping capacity of the muscle

The function of the muscle veins may be compared to that of a suction pump or a bellows we therefore suggest the term bellows veins for these veins

GREITZ and GULLMO have both described a varying filling of the muscle veins with contrast medium as normal BAUER (1948) and HOJENSGÅRD (1949) believed that a filling of these veins is a sign of pathologic changes It would appear to the writers that filling of the muscle veins is not evidence of a pathologic condition a filling of the muscle veins from the deep venous system of the lower leg is part of the normal mechanism of the muscle pump

Muscle veins will appear well filled in the phlebogram only if their normal blood content is first expelled by compression of the vessels on contraction of the muscles of the leg systole and then refilled during relaxation, diastole, with blood and contrast medium from the deep veins

SUMMARY

The phlebographic changes of the normal lower leg during contraction and relaxation of the calf muscles are described with special reference to the superficial veins deep veins and muscle veins The significance of the role played by the muscle veins in the venous heart is stressed

ZUSAMMENFASSUNG

Es werden die phlebographischen Veranderungen der normalen unteren Extremitat wahrend Kontraktion und Erschlaffung der Wadenmuskel mit Hinsicht auf die oberflachlichen tiefen und Muskelvenen beschrieben Die Bedeutung der Muskelvenen im venosen Herz wird hervorgehoben

RÉSUMÉ

L auteur décrit les modifications phlébographiques de la jambe normale pendant la contraction et la relaxation des muscles du mollet et en particulier les modifications des veines superficielles profondes et musculaires Il souligne l importance du role qu jouent les veines des muscles dans le cœur veineux

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MYOGRAPHY OF THE MULTIFIDUS MUSCLE

by

SUCK RIN KANG

In an attempt to test the usefulness of myography for the demonstration of pathologic conditions of muscle it was planned to perform myography in regions where pain occurs in association with an affection of a bone joint or nerves The multifidus muscle in the region of L4 and L5 was chosen as a suitable site of injection of contrast medium for the investigation Upon injection of contrast medium into the sacrospinalis muscle in patients suffering from low back pain but without previous neurologic signs or roentgenologic changes BERG (1959) demonstrated roentgenographic evidence of considerable tightening of the muscle Similar examinations of normal subjects were not performed

Our investigation was performed in normal subjects as well as in patients suffering from low back pain The multifidus muscle originates from the groove at the dorsum of the sacrum between the spinous and articular processes, from the posterior sacroiliac ligaments from the medial posterior part of the iliac crest and from the deep surface of the aponeurosis of the sacrospinalis and is inserted into the spinous processes of the 4th and 5th lumbar vertebrae The muscle plays an important part in the movement of the spine and pelvis by its anatomical relationship to the sacroiliac region and the lower lumbar vertebrae as well as to the L4 —L5 disk The muscle by its unilateral action flexes and rotates the vertebral column towards the opposite side and, together with its fellow, extends the pelvis (Fig 1)

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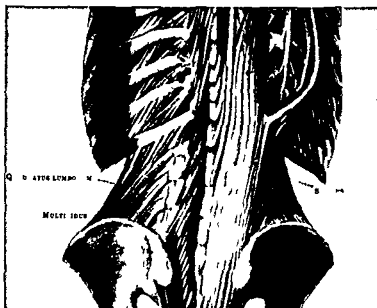
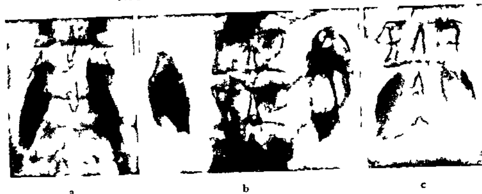


Fig 1 Normal anatomy of the multifidus muscle The fibres are directed upwards and medially to the spine whereas those of the sacrospinalis muscle run upwards but laterally to the spine (From CUNNINGHAM's Textbook of Human Anatomy)

To eliminate any psychologic effects the examinations were performed (1) in a group of patients under general anesthesia, (2) in another group under local anesthesia, and (3) in patients suffering from low back pain caused by proved lesions affecting a bone or the joints or nerves in the lumbosacral region

Technique

Myography of the multifidus in subjects under general anesthesia The patient is placed in the prone position on the examination table The spinous process of L5 is first localized, it usually lies at the level where the sharp downward inclination of the posterior iliac crest begins The injection should be made about 2 cm above the spinous process of L5 corresponding to the lateral margin of the intervertebral space between L4 and L5 In cases of deformity of the lumbar spine or pelvis, in which it may be difficult to determine the site of injection, a preliminary film with lead markers may be helpful Bilateral and simultaneous myography of the multifidus are always performed The needle is inserted perpendicularly through the subcutaneous tissue until a resistance due to the fascia of the sacrospinalis muscle is felt the fascia L5 is then punctured and the needle advanced a further 1 cm The contrast medium, 3 ml Hypaque 45 %, is injected slowly on both sides (during about 50 to 60 seconds) The patient is then turned into the supine position and an a p view of the lower lumbar spine including the sacroiliac joints is obtained a minute



a b c

Fig 2 a) Normal mult fidus myography during local anesthes a b) Inject on into the sacrospinal muscle c) Mult fidus myography in a case of disk herniat on between L4 and L5 on the left s de Sc l o s of th lumbar spine to the left Contraction and shorten ng of both muscles Right multifidus angle increased the left dec eased

	Multifidus angle	Length	W dth
Fig 2 c { R ght	30	40 mm	20 mm
Left	13	40 mm	20 mm

later The patient should remain in this position on the table and a further roentgenogram should be obtained one and a half hours following the first film No special precautions are needed after the examination

Myography of the multifidus muscle during local anesthesia Local anesthesia is produced by the injection of 2 ml Xylocaine 0 5 % The back muscles should be relaxed Only small areas of skin and subcutaneous tissue and not regions below the sacrospinal fascia are anesthesized During the injection of the contrast medium the patient feels only a slight dull pain which however completely disappears within a minute Since no side effects of the myography were observed in either of the two groups and since there was no difference in the results obtained the myographies were afterwards carried out under local anesthesia It may be mentioned in this connection that in experimental gluteal myography in rabbits no pathologic changes were observed two weeks after the injection the histologic appearances were found to be the same in the muscle that had been subjected to myography as compared to the one that had not

Results

Normal roentgenographic appearances of the multifidus muscle Twenty subjects without low back symptoms were examined 10 under general anesthesia and 10 under local anesthesia The patients had been admitted to hospital for conditions other than those affecting the spine The examination was suc cessful in 13 cases 7 of which were in the general anesthesia group and 6 in the local anesthesia group

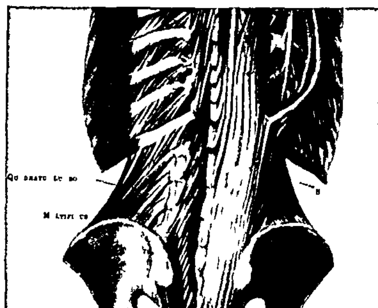


Fig 1 Normal anatomy of the multifidus muscle The fibres are directed upwards and medially to the spine whereas those of the sacrospinalis muscle run upwards but laterally to the spine (From CUNNINGHAM's Textbook of Human Anatomy)

To eliminate any psychologic effects the examinations were performed (1) in a group of patients under general anesthesia, (2) in another group under local anesthesia, and (3) in patients suffering from low back pain caused by proved lesions affecting a bone or the joints or nerves in the lumbosacral region

Technique

Myography of the multifidus in subjects under general anesthesia The patient is placed in the prone position on the examination table The spinous process of L5 is first localized, it usually lies at the level where the sharp downward inclination of the posterior iliac crest begins The injection should be made about 2 cm above the spinous process of L5 corresponding to the lateral margin of the intervertebral space between L4 and L5 In cases of deformity of the lumbar spine or pelvis, in which it may be difficult to determine the site of injection, a preliminary film with lead markers may be helpful Bilateral and simultaneous myography of the multifidus are always performed The needle is inserted perpendicularly through the subcutaneous tissue until a resistance due to the fascia of the sacrospinalis muscle is felt the fascia L5 is then punctured and the needle advanced a further 1 cm The contrast medium, 3 ml Hypaque 45 %, is injected slowly on both sides (during about 50 to 60 seconds) The patient is then turned into the supine position and an a. p. view of the lower lumbar spine including the sacroiliac joints is obtained a minute



Fig 4 Multifidus myography a) Case of Bechterew s disease Both muscles straightened with right muscle tight and multifidus angle decreased Delayed contrast medium absorption on right side b) Case of tuberculous spondylitis non operated with destruction of Th11—L3 marked kyphosis and bilateral paravertebral abscess immediately after injection c) 60 min after injection Complete absorption of the contrast medium Irregular short flattened muscles on both sides

	Multifidus angle		Length		Width	
	a)	b)	a)	b)	a)	b)
Right	1?	29	75 mm	50 mm	15 mm	27 mm
Left	10	27	80 »	50 »	24 »	25 »

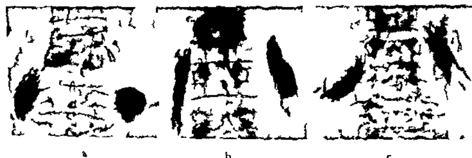


Fig 5 Multifidus myography in three cases of tuberculous spondylitis non-operated a) Extensive destruction of L3 and L4 kyphosis and bilateral psoas abscess Both muscles flattened and shortened and fibres markedly contracted No delayed absorption of contrast medium b) Partial destruction of left side of L3 and L4 and paravertebral abscess Right muscle straightened and contracted with irregular contour Left muscle only irregular Decrease of multifidus angle Compared with the cases illustrated in fig 4b and 4c the spine and muscle changes are less marked c) Extensive destruction of L5 partial destruction of L4 and S1 kyphosis and bilateral paravertebral abscess Both muscles markedly irregular No normal muscle fibres evident Left muscle edematous Probably inflammatory process in both muscles but mostly in the left (Even in the film obtained at 2 hours after the inject on a small amount of medium remained in the muscles)

	Multifidus angle			Length			Width		
	a)	b)	c)	a)	b)	c)	a)	b)	c)
Right	23	14	45	48 mm	70 mm	50 mm	26 mm	10 mm	12 mm
Left	52	15	26	30 »	65 »	60 »	24 »	?2 »	20 »

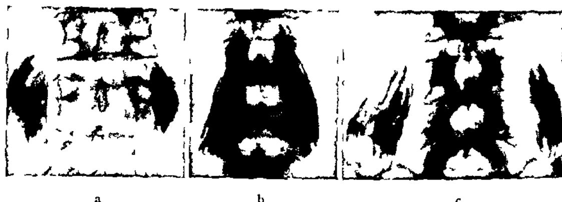


Fig 3 Multifidus myography a) Case of herniated disk between L5 and S1 on the left side Both muscles abnormally short with right muscle somewhat edematous and flattened Multifidus angle decreased b) Case of decreased lumbar lordosis Both muscles are almost normal in shape apart from some straightening Multifidus angle decreased especially on the right side The contrast absorption time exceeded 90 min The patient had been in bed 5 days c) Patient bedridden due to renal tuberculosis Both muscles markedly edematous i e separation of muscle fibres The medium was retained in both muscles even after 2 hours

	Multifidus angle			Length			Width		
	a)	b)	c)	a)	b)	c)	a)	b)	c)
Right	13	11	20	50 mm	80 mm	65 mm	28 mm	20 mm	34 mm
Left	10	15	23	43 »	80 »	60 »	17 »	20 »	25 »

With a correct technique the roentgenograms of the normal multifidus muscle will appear almost symmetrical (Fig 2a) The contours of the muscle fibres are well and regularly outlined by the contrast medium The muscle appears spindle shaped, widest in the middle and gradually narrowing towards both ends The borders of the normal muscle are smooth

The length and maximal width of the muscle have been measured and the direction of the muscle fibres has been examined Each fibre passes obliquely upwards and medially to the spine in comparison with the sacrospinalis muscle (Fig 2b) in the lower lumbar region which passes obliquely upwards but laterally to the spine

The following method was tentatively used for examining the running direction A line (A) is drawn connecting both iliac crests, and a line (B) through the spinous process of S1 is traced perpendicularly to line (A) Line (B) usually represents the normal course of the spine Another line (C) is drawn parallel to the middle multifidus muscle fibres, the angle produced by lines (B) and (C) we term the 'multifidus angle'

The time of absorption of the contrast medium was determined by obtaining films at certain fixed intervals after the injection The medium in normal cases was found to have been absorbed one and a half hours after the injection, and it therefore appeared that a film immediately after the termination of the injection, and another 90 min later, would be adequate for routine purposes

Conclusions

Ten cases of herniated disk 10 cases of renal tuberculosis and about 50 cases of tuberculous spondylitis all associated with low back symptoms were examined by means of myography of the multifidus muscle A normal control material was also examined The herniated disk cases showed straightening and shortening of the muscles the muscles in bedridden cases presented evidence of markedly edematous contours Inflammatory processes of the multifidus muscle were demonstrated in the myographies of the active tuberculous spondylitis cases The differences between the myography findings before and after operation corresponded well with the clinical pictures

SUMMARY

Myography of the multifidus muscle was performed in a material of about 100 cases of various conditions all associated with low back pain and including normal controls The technique of the procedure is described and the findings are considered

ZUSAMMENFASSUNG

Die Myographie des Musculus multifidus ist in einem Material von etwa 100 Fallen verschiedener Krankheitszustande die alle mit Kreuzschmerzen verbunden waren sowie von normalen Kontrollfallen durchgefuhrt worden Die Untersuchungstechnik wird beschrieben und die Befunde werden besprochen

RÉSUMÉ

L auteur a fait des myographies du muscle multifide (transversaire épineux) sur une série d environ 100 cas de diverses affections toutes accompagnées de douleurs lombaires et sur des sujets normaux Il decrit la technique de cet examen et en étudie les résultats.

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Fig 6 Multifidus myography in a case of tuberculous spondylitis with destruction of L5 L4 and L3 and paravertebral abscess a) Before operation the contours of both muscles markedly irregular b) Two months after operation the shape of the left muscle was completely changed and had become regular Right myography unsuccessful

	Multifidus angle	Length	Width
Right	23	60 mm	15 mm
Left	26	60 »	23 »

Although the normal material must be considered too small for definite conclusions it may be interesting to note the following measurements obtained from this material

The multifidus angle varied between 17° and 21 with an average of 19 1°

The length of the muscle varied between 60 and 75 mm with an average of 65 6 mm

The maximal width of the multifidus varied between 15 and 21 mm with an average of 18 8 mm

Roentgenographic appearance of the multifidus muscle in pathologic conditions Myography has been performed in a material consisting of cases of various conditions associated with low back symptoms and included 10 cases of herniated disk, 10 cases of renal tuberculosis and about 50 cases of tuberculous spondylitis The findings in some of the cases are illustrated in Figs 2c, 3, 4, 5, and 6 In cases of disk herniation straightening and shortening of the muscles occurred and in patients bedridden for a long time markedly edematous contours of the muscle were evident In the active spondylitis cases, inflammatory processes of the multifidus muscle were clearly demonstrated and there was good correspondence between the clinical pictures and the myographic findings before and following operation



Fig 1 Case 1 a) Cont action of both external l ac art ies rapidly increas ng peripherally the ar ter es of the th gh being strongly cont acted The left common il ac artery moderately contracted b) N ne days later the contractions had disappeared

Case reports

Case 1 Woman aged 34 who had had rapidly progressing ischemia of the lower extremities and was admitted with probable acute embolism at the bifurcation of the aorta On ad mission an obese subject The temperature of the skin of the feet was lowered and of bluish black colour the skin temperature about 10 cm below the knee joints was also decreased The right femoral artery could just be palpated but otherwise no pulse could be felt in either leg It transpired that six days before admission the patient had taken six vegetropin each contain ng 0 3 mg ergotamine tartrate

At *translumbar aortography* no evidence of embolism was found There was however a con siderable degree of contraction of the pelvic arteries and arteries of the thigh in spite of the fact that the examination had been performed under general anesthesia The external iliac arteries were equally contracted and the femoral arteries were particularly affected (Fig 1a) No appreciable contraction was evident in the lower part of the abdominal aorta or in the right common iliac artery but the left common iliac artery was moderately contracted

Vasodilatory treatment was given in the form of continuous spinal anesthesia together with the usual drugs. The patient s condition rapidly improved and further aortography

FROM ROENTGENDIAGNOSTIC DEPARTMENT II (DIRECTOR TURE L. ANDERSSON), CENTRALLASARETTET, ÖREBRO, SWEDEN

ANGIOGRAPHY IN TWO CASES OF ERGOTISM

by

K.-Å. JOHNSSON

The ergot derivatives have been recognised for a number of decades as among the best drugs for headache, particularly migraine. Individual sensitivity to ergot derivatives varies widely, however, and cases are described in the relevant literature in which gangrene has been observed after a total of 14 to 20 mg had been administered during a period of 14 days, in other cases there were no signs of side effects despite the fact that the daily dosage was 1.5 to 2.25 mg over a period of 8 years, which amounts to 4 380 to 6 570 mg (FRIEDMAN et coll.). The mechanism of the ergot preparations in general use, i. e. ergotamine tartrate (gynergen and dehydroergotamine) is in the main vasoconstrictive. The preparations also have a sympathicolytic effect, which does not occur however in patients with intact autonomous innervated vessels (BLUNTSCHLI et coll.). Most authors agree that certain disposing factors must be present in order for signs of ergotism to appear, these are primarily obliterating vascular diseases and sepsis (VON STORCH, THOMPSON). In accordance with their degree of severity, the side effects may be divided into the following groups: (1) indisposition and vomiting, (2) coronary spasm due to the constriction of the coronary vessels, (3) muscular cramps, probably on account of vascular spasms and ischemia, (4) ergotism, with, at the outset, a certain fumbling followed by cyanosis and paresthesias of the extremities and, in the final stage, gangrene.

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Fig 2b Case 2 Cf fig 2a preceding page Two weeks later the main vessels were distinctly wider

All ergotamine medication was discontinued After some days further oscillometric tests showed practically normal values The condition of the patient improved rapidly and her symptoms disappeared almost completely Further aortography revealed that the femoral arteries of the thighs had increased in width particularly above the knee joints the vessels of the collateral circulation were of normal size (Fig 2b)

Discussion

There appears to be no record in the literature of vascular changes due to ergotism demonstrated by means of angiography Finger plethysmography and oscillometry have been the main methods used The two cases of ergotism now reported represent different types of ergotamine poisoning The first case had such an acute and fulminating course that the case was at first considered to be one of embolism and aortography was performed this case was probably one of hypersensitivity to ergotamine The second case represented chronic poisoning and displayed less alarming symptoms

A striking feature of the arteriographic appearances was the distribution of the vasoconstriction The abdominal aorta and its intra abdominal branches were only slightly involved and the common iliac arteries were not appreciably



Fig 2a Case 2 Moderate degree of contraction in the proximal two third of both femoral arteries The distal parts markedly contracted particularly on the right side where wide branches form a collateral circulation (cf fig 2b next page)

nine days after admission (with insertion of a catheter into the lower part of the abdominal aorta) showed that the vessels had almost *resumed their* normal appearances (Fig 1b) The patient when discharged was practically free from symptoms

Case 2 Woman aged 35 with migraine for 13 years gradually increasing in severity Both her parents had been similarly affected Three years previously she had begun to take 3 to 4 tablets of cafergot, each containing 1 mg ergotamine tartrate at each attack she had had the attacks several times a week The *previous* year she had used anervan suppositories each containing 1 mg ergotamine tartrate 2 to 3 *times* a day The patient had noticed that her hands and feet had become considerably colder during the previous year and when she had gone for long walks had felt numbness in the legs which compelled her to stop she had also had numbness at times in the hands

On admission the hands and feet were distinctly cold and the toes slightly cyanotic The pulse taken in one femoral artery was appreciably weaker than normal no pulse could be felt in the popliteal artery or in dorsalis pedis Oscillometry disclosed abnormal values

At *aortography* with the insertion of a catheter into the abdominal aorta no changes were evident in the aorta and its larger branches The femoral vessels were slightly narrowed in their upper and middle parts of the thigh but tightly contracted in their lower parts particularly on the right side with evidence of a collateral circulation and dilated vessels (Fig 2a)

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LARYNGOCELE INTERNA

Report of a case

by

IRENE GLANZ and HANS SALINGER

Laryngocele ventricularis or aerocele laryngis is a rare anomaly of the human larynx. This malformation was first described in 1829 by LARREY, a surgeon in the French army in Egypt who saw these changes in a *muezzin* a Mohammedan crier who proclaims hours of prayer from a minaret. LARREY called the condition goitre aerien ou vésiculaire. The term laryngocele employed today was given to the anomaly by RUDOLF VIRCHOW in 1867. About 90 cases have been published to date but only in the last years have the roentgenologic appearances been described (BLEWETT 1939, CAULK 1941, PENDERGRASS & HODES 1956, *BURKE* & GOLDEN 1958 and ISSA 1961).

A laryngocele is a kind of herniation of the laryngeal wall developing from the ascending part of the ventricle Morgagni called the sacculus or appendix ventriculi. In the normal human subject the sacculus is a narrow cleft extending between the plica ventricularis and the inner aspect of the thyroid cartilage; this narrow cleft is a rudimentary rest of a large air sac of some anthropoids serving as an air reservoir and used during fixation of the thoracic respiratory muscles (FREEDMAN 1938).

According to LINDSAY (1940) there are three variations of laryngocele: (1) internal laryngocele in which the air sac is situated entirely inside the laryngeal cavity; (2) external laryngocele in which the air sac extends through a defect in the hyothyroid membrane into the extralaryngeal soft parts of the neck; (3) mixed form.

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affected. The vasoconstriction in both the cases commenced to appear high up and increased extremely rapidly in the lower parts of the femoral arteries. In the chronic case the vasoconstriction was considerably more peripheral, distal parts of the femoral artery being most affected. In addition there was evidence of a collateral circulation.

SUMMARY

Two cases of ergotism in which angiography was performed are presented.

ZUSAMMENFASSUNG

Zwei Fälle mit Ergotismus, bei denen eine Angiographie durchgeführt wurde, werden vorgelegt.

RÉSUMÉ

Présentation de deux cas d'ergotisme dans lesquels une angiographie a été pratiquée.

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gen examination of the lungs revealed old fibrotic changes at the apices No other changes evident

Control examination of the larynx three months later showed no change in the appearances The patient however complained of feeling a lump in his throat to the left of the hypopharynx During Valsalva manoeuvre a slight enlargement of the air sac could be seen The final control was made fifteen months after this examination The bulging mass appeared on laryngoscopy to be slightly larger but no other abnormality could be found A further biopsy showed a normal mucosa

Discussion

This case belongs to the rarer group of internal laryngocele The history of coughing during the period of treatment for tuberculosis of the lungs suggests that the repeatedly elevated pressure in the laryngeal cavity might have been responsible for the development of the bulging of the sacculus wall in a congenitally weak tissue The pressure of the air filled sac displaced the left sinus piriformis and explains the sensation of a foreign body in this region as reported by the patient

A study of the literature revealed that quite a number of publications concerned subjects from oriental countries, i e Egypt (LARRAY 1829) and Iraq Libanon and Palestine (ISSA 1961) The guttural manner of speaking in many oriental languages may be one of the determining factors for the development of these changes

Whereas the clinical and laryngoscopic picture may be equivocal and may suggest a tumor the roentgen examination readily establishes the diagnosis The exceptions are the few cases of laryngopyocele (FREEDMAN 1938, CHESSEN & LUTER 1955) in which filling of the sac with pus as a result of the inflammatory obstruction of the ventricular entrance obliterates the lumen especially in the supine position and abolishes contrast difference between the air and the soft parts But apart from the fact that the clinical and laryngoscopic findings will probably suggest an inflammatory process roentgenography with the patient erect will show air above a fluid level A tumor filling the sacculus will probably not be long confined to the region but appear in the entrance of the ventriculus

The rare lateral diverticula of the pharynx (KAUFMANN 1956) may be differentiated from a laryngocele by a swallow of barium emulsion when the cavity sometimes containing air will be filled for a short time by the contrast medium This of course will never occur in a laryngocele

SUMMARY

A case of laryngocele ventricularis an air containing dilatation of the ascending part of the ventriculus Morgagni is described The appearances diagnosis and differential diagnosis are discussed



Fig 1 Lateral roentgenogram of larynx Large air bubble protruding cranially



Fig 2 A p tomogram air bubble extends into region of left aryepiglottic fold left sinus piriformis displaced

The laryngocele may be congenital or acquired, and in the latter case different factors may be responsible, such as an elevated intralaryngeal pressure, caused for instance by chronic coughing, habitual shouting, blowing a wind instrument, or local changes in the ventricular wall, or in the vocal cords bordering the entrance to the ventricle, such as chronic inflammation, scars, tumors (SCHALL 1944, MEDA 1952) This last group requires special diagnostic attention Roentgen examination facilitates the final diagnosis which is not so easily made in a living subject without operation Tomography is an important procedure as in most conditions of the larynx

Case report

A man aged 59 a baker born in Turkey came to the hospital complaining of hoarseness He had been in another hospital seven years previously with tuberculosis and had had a severe cough General examination showed nothing abnormal On laryngoscopic examination considerable thickening of the left aryepiglottic fold and oedema of the vocal cords were evident Biopsy indicated slight inflammatory changes but no malignancy

On roentgen examination an air bubble the size of a pigeon s egg surrounded by a small soft tissue layer bulged cranially from the level of the ligamentum ventricularis and filled a large part of the infra epiglottic space (Fig 1)

Tomography (*Fig* 2) showed the bubble to the left of the larynx and extending into the region of the left aryepiglottic fold The right sinus piriformis was normal the left was displaced cranially and laterally as a result of the pressure produced by the air bubble Roent

FROM THE DEPARTMENT OF RADIOLOGY (DIRECTOR A BRADLEY SOULE) UNIVERSITY OF VERMONT COLLEGE OF MEDICINE AND AFFILIATED HOSPITALS BURLINGTON VERMONT U S A

MIDDLE CEREBRAL ARTERY ANATOMICAL AND RADIOGRAPHIC STUDY

by

B ALBERT RING

The middle cerebral artery supplies the largest area with the most complex branching of any of the intracerebral vessels The anatomy of the middle cerebral artery in relation to occlusion of its branches was described in detail by FOIX and LEVY in 1927 just prior to the introduction of cerebral angiography, but the anatomical divisions were not well suited to radiographic recognition and MONIZ (1940) preferred to designate the entire middle cerebral artery system as the Sylvian group The commonly accepted nomenclature at this time is that of four main branches of the middle cerebral artery exclusive of the lenticulostriate arteries these being the ascending frontal otherwise known as the candelebra group or the ascending frontal parietal the posterior parietal angular and posterior temporal The primary differences between this classification and that of anatomists is in the nomenclature of the ascending frontal artery the branches of which were given individual names by the original investigators and the anterior temporal artery supplying the temporal pole and the antrolateral aspect of the temporal lobe which has been omitted from neuroradiologic descriptions

Although the nomenclature is fairly well established among neuroradiologists there is some difference of opinion as to the usual course and origin of these vessels GREITZ and LINDGREN (1961) describe the four vessels as commonly arising proximally from the main trunk of the middle cerebral

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ZUSAMMENFASSUNG

Ein Fall von ventrikularer Laryngocele einer luftgefullten Erweiterung des aufsteigenden Teiles des Ventrikulus Morgagni wird beschrieben Das Aussehen die Diagnose und Differentialdiagnose werden besprochen

RÉSUMÉ

Description d un cas de laryngocele ventriculaire qui est une dilatation remplie d air de la partie ascendante du ventricule de Morgagni Les auteurs en étudient les signes le diagnostic et le diagnostic différentiel

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artery, while PEEL (1954) depicts one main trunk distal to the origin of the ascending frontal that breaks up into the three remaining branches. ECKER (1951) states that there are usually 2 or 3 main trunks in the Sylvian fissure. Other opinions are summarized by PENDERGRASS, SCHAEFFER and HODES (1956) in their text.

The following study was carried out for a better understanding of the anatomy of this area, especially as it applies to cerebral vascular disease. The material consisted of 50 middle cerebral arteries from 25 adult brain specimens without gross abnormalities from the routine post mortem service of the Mary Fletcher Hospital and 100 *normal carotid angiograms* performed within the past two years at the Mary Fletcher and deGoesbriand Memorial hospitals. Cases with mild to moderate atrophy and/or arteriosclerosis without actual obstruction were included in both clinical and autopsy material. The brain specimens were studied by dissections and drawings and radiography of contrast injected isolated branches was performed in some cases. This latter method was only useful in outlining branches arising proximal to or at the mouth of the Sylvian fissure, however, since exposure of all major branches for isolated *injection caused vascular tears with leakage of contrast*. The *angiograms* were studied by tracings on oleum paper.

The findings are given under the appropriate subheadings. Some of the data was derived entirely from specimens, other only from angiograms. To avoid confusion when comparative figures are given for both angiograms and specimens, the numbers for both are expressed as percentages. The lenticulostriate arteries are not included in this study as they have been well documented previously (ANDERSEN 1958).

Division of the middle cerebral artery. In the 25 brains studied, the 50 middle cerebral arteries showed ten distinct forms of division and there is no reason to believe that this exhausts the possibilities. Since the variations are too numerous to be of any value when listed separately, a simplified tabulation is given as follows:

One major vessel arising proximal to fissure	34
More than one major vessel arising proximal to fissure	26
Trifurcation at the mouth of the fissure	24
Bifurcation at the mouth of the fissure	16

In the majority of cases, one or more vessels arose proximal to the fissure and the division of the remaining trunk in the mouth of the fissure was made up of somewhat irregular branchings and re-branchings without any constant pattern. As seen from the tabulation, a clear cut trifurcation or bifurcation as the primary form of branching in the mouth of the fissure occurred only in a minority of the cases.

Main trunks in the Sylvian fissure To insure uniformity, we arbitrarily defined main trunks in the Sylvian fissure as those major vessels passing without interruption through the middle third of the fissure However it was impossible to be certain of the number of vessels in 22 % of the angiograms Stereoscopic films were not available but we doubt that they would solve this problem as in the specimens with the vessels exposed the main trunks frequently could not be distinguished from their branches without physically separating each vessel The findings are tabulated as follows

Number of main trunks	Brain specimens	Angiograms
1	34	13
2	38	42
3	24	19
4	4	4
Unknown	0	22

The artery to the posterior temporal area was often found to leave the Sylvian fissure in the proximal third so under these circumstances by our definition this vessel was not included among those passing through the Sylvian fissure With or without this vessel the presence of two main trunks seems to be the commonest feature although this group still makes up less than half of the total Counting the main trunks as a means of diagnosing occlusion of one branch of the middle cerebral artery obviously is of no value It is also obvious that the few cases with 4 main trunks in the mid third of the fissure which is distal to the origin of the ascending frontal artery have one extra vessel and in these cases some area was found to be receiving a double blood supply A double blood supply to one area may occur in the absence of this extra vessel however and a few such cases were found in which a double blood supply to some area existed with three or less major vessels passing through the Sylvian fissure

Anterior temporal artery The anterior temporal artery is described by PEEL as a large vessel that is the first given off and that supplies the temporal pole and the superior and lateral surfaces of the temporal lobe anteriorly In our experience this vessel is usually small and the radiologic neglect is probably due to its small size and its course which make it very difficult to identify on the normal angiogram This vessel was found to usually arise from the proximal portion of the middle cerebral trunk on its anterior surface very often directly opposite the lenticulostriate vessels except in cases where the posterior temporal arises in this location Under these circumstances the anterior was usually a branch of the posterior temporal artery The anterior temporal artery runs directly anteriorly over the superior surface of the temporal lobe and divides with small branches continuing down over the

artery, while PEEL (1954) depicts one main trunk distal to the origin of the *ascending frontal* that breaks up into the three remaining branches ECKER (1951) states that there are usually 2 or 3 main trunks in the Sylvian fissure Other opinions are summarized by PENDERGRASS, SCHAEFFER and HODES (1956) in their text

The following study was carried out for a better *understanding of the anatomy of this area*, especially as it applies to cerebral vascular disease The material consisted of 50 middle cerebral arteries from 25 adult brain specimens without gross abnormalities from the routine post mortem service of the Mary Fletcher Hospital and 100 normal carotid angiograms performed within the past two years at the Mary Fletcher and deGoesbriand Memorial hospitals Cases with *mild to moderate atrophy and/or arteriosclerosis without actual* obstruction were included in both clinical and autopsy material The brain specimens were studied by dissections and drawings and radiography of contrast injected isolated branches was performed in some cases This latter method was only useful in outlining branches arising proximal to or at the mouth of the Sylvian fissure, however, since exposure of all major branches for isolated injection caused vascular tears with leakage of contrast The angiograms were studied by tracings on oleum paper

The findings are given under the appropriate subheadings Some of the data was derived entirely from specimens, other only from angiograms To avoid confusion when comparative figures are given for both angiograms and specimens, the numbers for both are expressed as percentages The *lentic ulostriate* arteries are not included in this study as they have been well documented previously *(ANDERSEN 1958)*

Division of the middle cerebral artery In the 25 brains studied the 50 middle cerebral arteries showed ten distinct forms of division and there is no reason to believe that this exhausts the possibilities Since the variations are too numerous to be of any value when listed separately, a *simplified tabulation is* given as follows

One major vessel arising proximal to fissure	34
More than one major vessel arising proximal to fissure	26
Trifurcation at the mouth of the fissure	24
Bifurcation at the mouth of the fissure	16

In the *majority* of cases, one or more vessels arose proximal to the fissure and the division of the remaining trunk in the mouth of the fissure was made up of somewhat *irregular branchings and re branchings* without any constant pattern As seen from the tabulation, a *clear cut trifurcation or bifurcation* as the primary form of branching in the mouth of the fissure occurred only *in* a minority of the cases

The anterior temporal artery was found to have an intimate and inverse size relationship to the posterior temporal artery as might be expected as the two supply overlapping areas When the former is large the latter is either small and arises more posteriorly or is replaced by multiple branches from varying sources A summary of our findings is tabulated as follows

Typical vessel arising from middle cerebral	44
Typical vessel arising from posterior temporal artery	12
Multiple vessels	16
Large recurrent branch	16
Other variations	12

One interesting anomaly was noted in which this vessel arose from the posterior temporal artery in the mid third of the fissure and ran anteriorly to bifurcate and supply the temporal pole In this case the recurrent branch ran exactly in a reverse manner to its usual course

Posterior temporal artery The artery to the posterior temporal area is discussed next because of its intimate relationship with the anterior temporal artery This vessel often arises as a separate trunk before reaching the fissure and usually comes off in an inferior direction This was the case in eleven of our fifty brain specimens excluding the eight large anterior temporal arteries, but in two cases the inferior branch resembling the posterior temporal artery was a branch to the ascending frontal area and in two other cases the posterior temporal artery arose superiorly outside the fissure resembling the ascending frontal artery It was not possible to sort out these variations with certainty on the angiograms This vessel often has a characteristic appearance on the lateral angiogram due to its making a hairpin turn as it leaves the Sylvian fissure but there is a large area supplied by this vessel and while its appearance may be fairly characteristic its course and the source of the total blood supply to the area are quite varied In general there are three components to the blood supply of the lateral aspect of the temporal lobe These are the recurrent branch of the anterior temporal artery which supplies the more anterior part the posterior temporal artery itself which supplies a quite varied area and occasionally is entirely absent and vessels of varying sizes from varying sources that course downward from the Sylvian fissure or from the posterior parietal or angular areas to make up the balance

As previously noted this vessel may leave the Sylvian fissure early, as was the case in 14 % of brain specimens and 21 % of the angiograms and when this occurs there is a characteristic angiographic appearance in the frontal views since the vessel is seen to be passing obliquely across the more or less horizontal loops of the remaining Sylvian vessels The variations are summarized as follows



Fig. 1. Orbital view of patient with traumatic edema of temporal pole. Anterior temporal artery is stretched and the branches to the temporal pole are more prominent than usual.

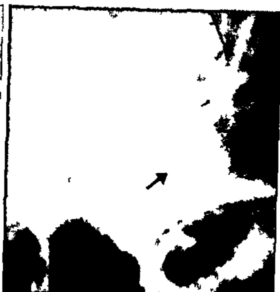


Fig. 2. Frontal view of patient with posterior temporal glioma elevating middle cerebral artery. Anterior temporal artery arises from the posterior temporal; the recurrent branch passes laterally just above rim of orbit.

temporal pole and a recurrent branch that runs back toward the fissure. This may run in the fissure, on its lateral margin, or over the lateral aspect of the temporal lobe. The branches to the temporal pole are universally small and can best be seen radiographically on an orbital view with the middle cerebral artery at the upper level of the orbit so that the temporal pole is seen en face. When the temporal pole is expanded, as by edema or intracerebral tumor in this area, the branches are more apparent (Fig. 1). These small branches are of some help in differentiating intra- from extra-cerebral masses elevating the temporal pole, since in the former they are stretched and in the latter elevated and compressed.

The anterior temporal artery is at times a fairly sizable artery as was found in 16 % of brain specimens. In these cases the branches to the temporal pole are of their usual small size but the recurrent branch is so large as to resemble the posterior temporal artery. As an arbitrary dividing line, we considered those vessels reaching no further posteriorly than the end of the fissure as anterior temporal arteries, and those extending beyond this point as posterior temporal arteries. The radiographic recognition of the recurrent branch is difficult in the normal frontal projection, but elevation of the middle cerebral artery may bring it into profile (Fig. 2). On lateral views it may occasionally be seen overlapping the anterior choroidal artery and may be confused with it. When this branch is large, it appears typical of the posterior temporal artery except for its smaller size.

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	Brain specimens	Angiogram
Single vessel typical appearance	60	60
Two vessels with anterior & posterior components	26	19
None recognizable — replaced by multiple vessels from various sources	4	6
Other variations	10	15

Ascending frontal artery. The middle cerebral artery is the most complex of the major intracerebral arteries and the ascending frontal is the most complex of its branches. This vessel supplies blood to a large area that can best be appreciated from a lateral carotid angiogram in cases where there is little or no filling of the pericallosal vessels. Partly, the complexity of this vessel is due to its large size and numerous branches and partly to the anatomy of the area, since vessels passing up the medial aspect of the Sylvian fissure are infolded with the insula so they appear to loop upon themselves.

The term 'candelabra group' comes from the shape of the major branches making up the complex. The main trunk of the ascending frontal artery usually bifurcates, or trifurcates, shortly after its origin, and the anterior and posterior branches bow downward before curving upward and re-branching so that they form a characteristic candelabra-like appearance.

LIMA is one of the few in the radiographic field to attempt to subdivide the branches of this vessel for practical diagnostic purposes. He describes three parts to the ascending frontal artery — the orbitofrontal branches, running on the orbital surface of the frontal lobe, the inferior frontal and the prerolandic. We were unable to make a satisfactory division, however. The orbitofrontal and the inferior frontal branches are easily recognizable on brain specimens but are seldom prominent on angiograms. In the brain specimens it was not uncommon to find the complex made of two vessels instead of a single main trunk, but the extra vessel had no constant relationship with the usual site of origin of the main trunk, and no satisfactory anatomical division was found that would apply to the angiographic appearance.

The origin and proximal course of this vessel, as well as the posterior parietal and angular arteries, could not be accurately traced from the angiograms so the data given is from brain specimens only.

1 main trunk typical candelabra	44
2 main trunks typical candelabra anterior	24
2 main trunks typical candelabra posterior	14
1 main trunk atypical division	8
Other variations	10

The typical candelabra form was present in 82 % of our cases although an extra vessel was associated with this in 38 %. In two cases, included in other variations, there were four medium size vessels coming of the middle cerebral artery in close succession in place of the usual main trunk.

Posterior parietal artery The posterior parietal artery supplies a relatively small area but the vessel to it is quite constant in its distal portion We found this vessel to arise most commonly from a trunk also supplying the angular the posterior parietal branch leaving the Sylvian fissure at its distal part and curving upward to its final arborization As previously noted, this vessel, as well as the angular may occasionally supply branches to the posterior temporal area Variations in this vessel as found in brain specimens are tabulated as follows

Shares one main trunk with vessel to angular area	52
Separate vessels through the Sylvian fissure	30
Two distinct vessels to the area	6
Other variations	12

Angular artery The angular gyrus forms the posterior margin of the Sylvian fissure and the vessel to it is logically referred to as the angular artery, or the artery to the angular gyrus In practice, the angular artery seems to supply primarily the inferior portion of the angular gyrus rather than its entire area This vessel was found quite similar to the posterior parietal artery with which it commonly shares its origin The vessel to the angular area, however usually curves less sharply being more of a continuation of the line of the Sylvian fissure and is directed slightly downward The anatomical variations found in the specimens are tabulated as follows

Shares a trunk with posterior parietal	52
Separate vessels through the fissure	32
Two distinct vessels to area	4
Other variations	12

Variations in two opposing hemispheres It has been noted that the appearance of the middle cerebral vessels may be quite different on two sides of the same individual We recorded general similarity and differences of the 25 brain specimens as regards the general course and appearance of the middle cerebral group grading the differences as none, slight moderate or marked In six cases the two sides were similar in eleven there were slight differences in five moderate differences and only in three were there marked differences It would appear that in general the two sides of one individual are more likely to be similar in appearance than the same group of vessels in another individual although marked differences between the two sides may occur

Discussion

The preceding data only include the more common variations since to tabulate the whole would be so long and involved as to be meaningless Greitz and Lindgren have mentioned possible variations in the origin of the main

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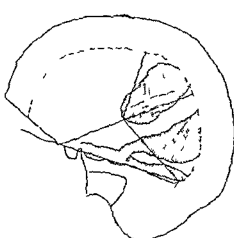


Fig 4 Composite drawing of the terminal course of the posterior parietal artery in 92 of 100 normal carotid angiograms (upper shaded area) and of the posterior cerebral artery in 25 of the same normal carotid angiograms (lower shaded area)

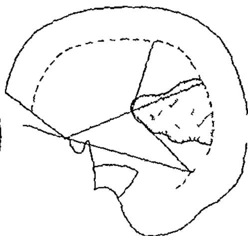


Fig 5 Composite drawing of the terminal course of the angular artery in 98 of 100 normal carotid angiograms

curve From the midpoint of this latter line a line is drawn upward to the inner curve roughly parallel to the coronal suture and downward to the position corresponding to the internal occipital protuberance on the inner curve This outlines four areas the anterior superior being the ascending frontal area, the posterior superior being the posterior parietal area the inferior posterior triangle shares the angular area in its upper two thirds with the posterior temporal area in its lower third, and the inferior triangle becomes exclusively the area of the posterior temporal artery

It should be emphasized that this is a radiologic and not an anatomical division and the areas are formed by the simplest possible means so that they may be recognized by inspection without the need for actual tracings measurements or templates

A composite of the terminal portions of the posterior parietal and angular arteries are shown in Figs 4 and 5 In the case of the posterior parietal artery the shaded area represents the composite course of 91 of the 100 vessels In the other nine the vessel to the area left the fissure early or was a branch from the ascending frontal artery and entered the area from in front, well above the Sylvian fissure In the case of the angular area the drawing is a composite of 98 of the 100 vessels Each of the other two appeared to arise as a large branch of the posterior temporal artery and ran directly upward from below to enter the area

The courses of the ascending frontal branches and the posterior temporal artery were too varied to make such a composite worthwhile although they

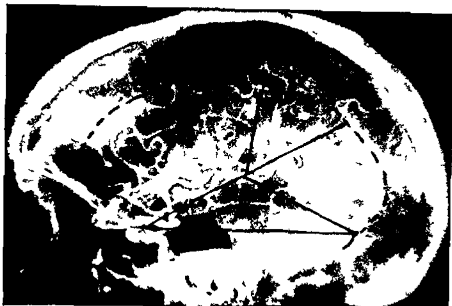


Fig 3 Division of the lateral carotid angiogram into four areas corresponding to areas supplied by the four major middle cerebral branches

branches of the middle cerebral artery, and from our experience almost any conceivable combination is possible For example, the ascending frontal artery may arise from a branch that appears to be the main trunk of the posterior temporal, angular, or posterior parietal arteries and the same principle holds true for any other vessel These conditions are generally included under 'other variations in the tables

Since the variations are so numerous, one might be tempted to forget individual branches and revert to MONIZ's method of viewing the entire middle cerebral complex as a group This may be satisfactory for detecting displacement but it is entirely inadequate for the diagnosis of occlusion of isolated branches of the middle cerebral artery, a condition which we believe is not infrequently the cause of small strokes

From the studies, both on angiograms and brain specimens, there was impressive evidence of the constancy with which various areas received their major blood supply irrespective of the course and origin of the vessel supplying it From this concept a method was developed of dividing the surface of the lateral carotid angiogram into various zones corresponding to the areas supplied by the four major vessels, excluding the anterior temporal artery The division is shown in Fig 3 and was made in the following manner A line is drawn parallel to the inner table of the skull at a 2 5 cm (1 inch) distance from it From the point on this line, corresponding to the internal occipital protuberance, a line is drawn to the limbus sphenoidalis and a line drawn through the axis of the Sylvian vessels from the floor of the skull to the inner

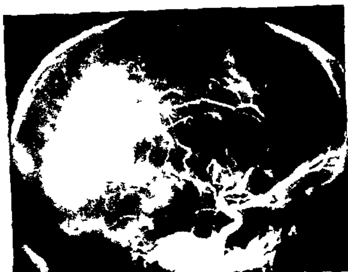


Fig 7 Patient with an acute st oke The absence of the vessel to the angular area and the paucity of vessels to the posterior parietal area are obvious

In the course of tracing the angiograms and preparing the divisions several cases were encountered that had previously been considered normal but on careful review showed a definite absence of normal blood supply to some area On re checking the history and clinical findings these patients were found to have had small strokes clinically compatible with the angiographic evidence of occlusion of the isolated branch One such case is shown in Fig 6 The absence of the posterior temporal artery is somewhat concealed by the prominent posterior cerebral artery but close examination of all available *films* showed a complete absence of vessels to the posterior temporal area diagnostic of occlusion of this vessel This is in contrast to Fig 7 where the occlusion involved a large trunk and is quite obvious

It is unlikely that all occlusions of small branches of the middle cerebral artery can be diagnosed angiographically The branches of the ascending frontal are so *numerous* and the orbitofrontal division so difficult to see that the occlusion would probably have to involve a large proximal trunk to produce a detectable absence of vessels The posterior temporal is often made up of more than one branch and *conceivably* an occlusion of one of these branches might cause a clinical stroke and not be recognizable on the angiogram In the few cases in which the posterior parietal and angular areas have a double blood supply, ab ence of one branch would not be detectable However, in spite of the limitations we believe more of these occlusions of smaller branches can be diagnosed at angiography through the better appreciation of the anatomy involved



Fig 6 Carotid angiogram from a 61 year old male with generalized arteriosclerosis Parkinson s disease and residual hemiparesis from acute stroke two years previously Occlusion of posterior temporal artery delayed filling of the pericallosal vessels

were seen to be satisfactorily contained in their respective areas on the angiograms As previously noted, the posterior temporal artery not infrequently terminates in the lower third of the triangle assigned to the angular It was felt easier to remember this fact than to further complicate the manner of division of the areas to allow for it

The posterior cerebral artery does not rightly belong in this discussion but since its branches overlap those of the middle cerebral artery on the lateral *angiogram it cannot be entirely disregarded Of the 100 angiograms* there was complete filling of the posterior cerebral in 25 and a composite drawing of the course of this vessel and its two main branches is shown in Fig 4 It would appear that the inferior line outlining the posterior temporal area is a fair reference for the usual course of the lateral branch of the posterior cerebral artery However, since one absolute measurement is used, i e the 2 5 cm distance from the inner table of the skull, this will vary somewhat with head size and the degree of magnification

The smaller head size and slight difference in relative anatomy in children s angiograms does not appear to affect the validity of this system of division Children were not included in the study primarily because very few normal angiograms were available from this age group, but tracings and the divisions were made in a few cases and appeared to be satisfactory

FROM THE ROENTGEN DEPARTMENT (DIRECTOR PROF L ZUBIAURRE) AND THE CARDIOLOGIC LABORATORY (DIRECTOR PROF J DIGHIERO) UNIVERSITY HOSPITAL M QUINTELA MONTEVIDEO URUGUAY

PARTIAL ANOMALOUS PULMONARY VENOUS DRAINAGE INTO THE INFERIOR VENA CAVA

by

O FIANDRA A BARCIA R CORTES and J STANHAM

The anastomosis of the pulmonary veins with the right auricle or with veins of the systemic circulation is a relatively infrequent anomaly When the blood abnormally drained comes from one pulmonary lobe or from one lung no important alterations in function are evident the subject remains symptom free, and the condition is revealed only at roentgen examination operation or autopsy When the blood of the two lungs is totally drained into the systemic venous circulation the patient is cyanotic because an interauricular communication is necessary to allow a flow of mixed blood (arterial and venous) into the left auricle the condition would otherwise be incompatible with life The former condition is known as partial anomalous venous connection or drainage and the latter as total anomalous venous connection or drainage

The terms drainage and connection are based upon hemodynamic and anatomical factors respectively the reasons given by EDWARDS (1953) make us prefer the term connection

The importance in recognizing a partial anomalous venous connection lies in that it permits a correct interpretation to be made of the abnormal roentgenologic signs to which it gives rise the danger of surgical removal of the normally connected lung avoided and the diagnosis of alterations evident in diseases of the affected lung to be facilitated

A case of an anomalous pulmonary vein draining the blood of the right lung into the inferior vena cava is presented in this paper Of the partial anomalous

Submitted for publication 18 January 1961

The need of recognizing the individual branches of the middle cerebral is of less importance in localizing mass lesions, although in a general way it is axiomatic that the more detailed the knowledge of normal anatomy the easier it is to recognize the abnormal

In conclusion, the branches of the middle cerebral artery show numerous variations but an appreciation of the areas supplied by the major branches is of considerable value in understanding the anatomy of the group as a whole and in recognizing some cases of vascular occlusion

Acknowledgements

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SUMMARY

Variations in the branches of the middle cerebral artery are described and a method is presented of designating areas supplied by the major branches This has been found valuable in diagnosing occlusions of isolated branches of the Sylvian group

ZUSAMMENFASSUNG

Die Variationen der Verzweigungen der Arteria cerebri media werden beschrieben Eine Methode wird vorgelegt die es erlaubt die Gebiete anzugeben welche von den Hauptästen versorgt werden Diese Möglichkeit hat sich bei der Diagnostik von Okklusionen isolierter Äste der Sylviigruppe als wertvoll erwiesen.

RÉSUMÉ

L auteur décrit les variations des branches de l artere cerebrale moyenne et presente une nomenclature des aires irriguées par les principales branches Cette methode s est montree utile pour diagnostiquer les obstructions de branches isolees du groupe sylvien

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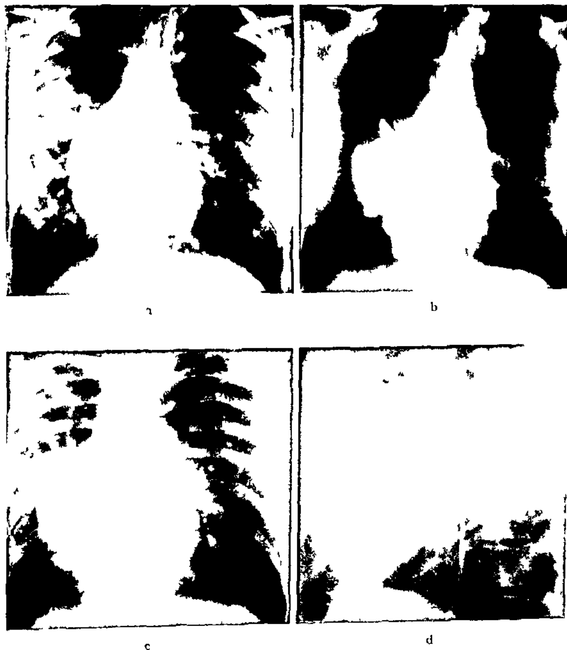


Fig 1 a) Conventional film frontal projection b) Tomography c) and d) Catheter in the abnormal vein

venous connections this is one of the less frequent We were able to find 48 cases in the literature, in 3 of these cases (COOPER (7), PARK (20), and UCHIDA (30)) we were unable to examine the original papers and our material is consequently based upon 46 cases, one of which is our own



F g 2 S lecti e a g ocard ography with the catheter n the abno mal ve n that dra ns all the lobes of the ght lung nto the nfe or vena ca a above the d aphragm The inferior vena cava is dilated at the c nnect on

Case report

Female aged 23 medical student without cardiovascular symptoms was thought to have an anomalous venous connection at routine roentgen examination The physical examination revealed a good general condition no changes in function Systolic pulsation in 3rd and 4th



Fig 3 Selective angiocardiography from the right atrium The right ventricle is displaced to the right and upwards

interspaces at right margin of sternum Normal heart sounds but with maximum intensity over the sternum and its right border No abnormal sounds heard Blood pressure 120/80 Brachial and femoral pulses regular and isochronous

Roentgen examination Symmetric thorax with displacement of the heart and mediastinum to the right arch of aorta not abnormal Obvious disproportion in the space occupied by the left lung in comparison with the smaller right side Moderate bilateral increased vascularity of the lungs with dilatation of the pulmonary artery and its two main branches and segmental arteries The right cardiac border appeared abnormally elongated and angulated and two vessels originating in the right upper lobe apparently ran into its upper part A catheter introduced into an anomalous pulmonary vein showed that one of the vessels was a tributary of the vein The left atrium and aorta were normal (Fig 1 c and d)

The presence of a venous trunk running towards the cardiac outline to end in the inferior vena cava was demonstrated at tomography (Fig 1b)

ECG revealed a postural change and hypertrophy of the infundibulum of the right ventricle

Cardiac catheterization Increase in the haemoglobin content of the blood in the inferior vena cava was found immediately above the diaphragm as compared to the rest of the inferior vena cava and the superior vena cava The catheter was introduced into the anomalous vein emptying into the inferior vena cava immediately above the diaphragm the haemoglobin saturation of the blood in this vein was 98 % An associated interauricular communication could not be demonstrated The value of the shunt produced by the anomalous vein was 30 % i e that for each 100 ml of the output of the pulmonary artery 30 ml came from the area drained by the anomalous vein The values of the pulmonary resistances were slightly below normal

Selective angiocardiography (Fig 2) The catheterization completed the patient was anesthetized and the tip of the catheter placed in the abnormally connected pulmonary vein After injection of 40 ml Urographin 76 % simultaneous frontal and lateral films (6 films/sec) were obtained (Elema film changer and Gidlund automatic injector)

A thick venous trunk formed by numerous veins that filled partially in a retrograde direction was demonstrated The tributary veins drained all the lobes of the right lung The abnor



Fig 4 a) Pulmonary artery and its branches b) Pulmonary veins connected on the left side with the left atrium and on the right side with the inferior vena cava

mal vein ran into the inferior vena cava above the diaphragm at the point of connection the inferior vena cava was greatly dilated and was displacing the right atrium upwards and to the right The right atrium formed the greater part of the right and anterior surface of the heart its appendage was prolonged upwards and medially more than the normal The right ventricle was also displaced to the right and upwards as shown by the angiocardiography performed from the right auricle (Fig 3)

A further injection of contrast medium was made into the right ventricle with the object of showing the ventricle independently from the auricle and of better demonstrating the arterial and venous circulation This was achieved and it was apparent that there was a marked increase in the calibre of the pulmonary vessels

Discussion

The case described is that of a young female without symptoms with an anomalous pulmonary vein that drained the whole of the right lung into the inferior vena cava above the diaphragm The angiocardiographic study revealed a dilatation of the inferior vena cava at the site of the connection with the anomalous vein as is usually evident with venous anomalies It appears to the writers that the alteration in the position of the heart was produced by this dilatation as one of the principal points of fixation of the heart is the inferior vena cava on the other hand had the connection been situated below the diaphragm the position of the heart would have remained unchanged

An attempt was made to establish whether there is any relation between



Fig 3 Selective angiocardiography from the right atrium The right ventricle is displaced to the right and upwards

interspaces at right margin of sternum Normal heart sounds but with maximum intensity over the sternum and its right border No abnormal sounds heard Blood pressure 120/80 Brachial and femoral pulses regular and isochronous

Roentgen examination Symmetric thorax with displacement of the heart and mediastinum to the right arch of aorta not abnormal Obvious disproportion in the space occupied by the left lung in comparison with the smaller right side Moderate bilateral increased vascularity of the lungs with dilatation of the pulmonary artery and its two main branches and segmental arteries The right cardiac border appeared abnormally elongated and angulated and two vessels originating in the right upper lobe apparently ran into its upper part A catheter introduced into an anomalous pulmonary vein showed that one of the vessels was a tributary of the vein The left atrium and aorta were normal (Fig 1 c and d)

The presence of a venous trunk running towards the cardiac outline to end in the inferior vena cava was demonstrated at tomography (Fig 1b)

ECG revealed a postural change and hypertrophy of the infundibulum of the right ventricle

Cardiac catheterization Increase in the haemoglobin content of the blood in the inferior vena cava was found *immediately above the diaphragm as compared to the rest of the inferior* vena cava and the superior vena cava The catheter was introduced into the anomalous vein emptying into the inferior vena cava immediately above the diaphragm the haemoglobin saturation of the blood in this vein was 98 % An associated interauricular communication could not be demonstrated The value of the shunt produced by the anomalous vein was 30 % i e that for each 100 ml of the output of the pulmonary artery 30 ml came from the area drained by the anomalous vein The values of the pulmonary resistances were slightly below normal

Selective angiocardiography (Fig 2) The catheterization completed the patient was anesthetized and the tip of the catheter placed in the abnormally connected pulmonary vein After injection of 40 ml Urographin 76 % simultaneous frontal and lateral films (6 films/sec) were obtained (Elema film changer and Gidlund automatic injector)

A thick venous trunk formed by numerous veins that filled partially in a retrograde direction was demonstrated The tributary veins drained *all the lobes of the right lung The abnor*

cases the azygos lobe was normally connected In another case it was probable that the whole of the right lung was drained In 5 cases only the inferior lobe and in 2 the upper lobe of the right lung was drained Finally in 19 cases the tributary field of the anomalous vein was not established

Hemodynamic alterations The abnormal drainage of pulmonary blood towards the systemic venous territory produces a hemodynamic alteration characterized by the incorporation of oxygenated blood in the venous stream that flows towards the lung A left to right shunt is thus produced similar to that of an interauricular communication This left to right shunt was determined in 8 cases its value expressed as percentage of the total output of the pulmonary artery, varied between 24 and 33 % In two cases associated with interauricular communication its value was 50 % In a case of VON STECKEN s the shunt was calculated at 72 %, we believe this was not the true value as the saturation of the blood of the vena cava below the connection of the anomalous vein was not determined No relation could be found between the magnitude of the shunt and the area of the pulmonary parenchyma abnormally drained

In none of the cases catheterized was pulmonary hypertension found only a moderate degree of increase of the pressure of the pulmonary artery was registered in some cases

A roentgenologic appreciation of the pulmonary vascularity was made in 27 cases in 17 it was diminished in the right lung in 15 it was increased in the left lung in 3 it was normal in both lungs and in one case it was increased in the right lung The difference in the vascularity of both lungs with an increase in the left lung and a decrease in the right lung is perhaps the cause of the low values of the shunt that the anomalous drainage produces

Anomalous arteries In 8 cases anomalous pulmonary arteries which arose directly from the aorta or from the diaphragmatic arteries that irrigated the right lung were described In one case an arterio venous aneurysm of the lung was present

Alterations in the pulmonary parenchyma In 12 cases parenchymatous alterations in the right lung were found These consisted of segmental hypoplasia generalized hypoplasia bronchiectasis abnormal bronchii and pulmonary sequestration In one case there was hypoplasia of the right hemi diaphragm

In 5 cases other associated cardiovascular malformations were present in one case VSD with over riding of the aorta pulmonary hypoplasia and PDA (CHASSINAT) in one case PDA and in 3 cases ASD

External thoracic asymmetry Thoracic asymmetry caused by a smaller right hemithorax was observed in 25 cases We believe that this may be another factor effecting the lower flow through the right lung

the site of the connection of the anomalous vein with the inferior vena cava and dextroposition of the heart Twenty two of the cases of the literature (1, 3, 8, 10, 13, 14, 18, 19, 21, 26—29, 31) had dextroposition of the heart, in 19 (3, 5, 6, 8, 9, 12, 13, 17, 21, 22, 23, 26, 27, 28, 32) the heart was not transposed, and in 5 cases (4, 8, 15, 17, 25) the position of the heart was not mentioned Of the cases with dextroposition, the anomalous vein was in 6 cases (2, 4, 20, 24, 26, 27) connected to the inferior vena cava above the diaphragm, in 7 cases (8, 14, 18, 19, 31) this was the probable site of connection, in 7 other cases (3, 8, 12, 13, 14, 16, 17, 28, 29) this was not specified Finally, in 2 cases (10 and 28) the connection lay below the diaphragm one had a diaphragmatic hernia and in the other case (10) the dextroposition was produced by displacement of the heart caused by atelectasis of the inferior lobe and hypoplasia of the middle lobe of the right lung

Nineteen cases had no transposition of the heart In none of them did the connection of the anomalous vein to the inferior vena cava lie above the diaphragm, in 7 cases (5, 6, 8, 9, 13, 21, 27) the connection was definitely below the diaphragm, in 8 cases (3, 9, 13, 17, 22, 23, 26, 32) this was the probable site of connection, and in 4 cases (3, 12, 13, 28) it was not specified

It was not clear in 5 cases (4, 8, 15, 17, 25) whether there was any change in the position of the heart In one of these cases (4) the connection lay above the diaphragm and in another (15) it was below

As previously mentioned, the cases of COOPER and PARK and UCHIDA were not analysed because we had no access to the original publications In PARK s case the connection lay above the diaphragm (BRODY 1942)

Identification of the anomalous vein Identification of the anomalous vein in the cases recorded in the literature was performed by roentgenologic examination, by catheterization, or by direct inspection at surgical operation or autopsy

Identification by the conventional roentgenologic examination was effected in 38 cases, the vein was not observed in 4 cases and in the remaining 3 cases a conventional roentgen examination was not performed Tomography demonstrated the anomalous vein in 17 cases The vein was shown by angiocardiography in 24 cases, in two of these (in VON STECKEN's and in ours) selective angiocardiography was carried out by the introduction of a catheter into the abnormal vein The anomalous vein was catheterized only in 6 cases, in none of these was it an incidental finding during the catheterization

The anomalous vein was found at autopsy in the cases reported by CHASSINAT, PARK, and UCHIDA, in one case of HALASZ s, and probably in COOPER s case In CABROL's case the diagnosis was made at operation

Lobes drained The anomalous vein may drain the whole or part of the right lung, no cases of drainage of the left lung have been described In 19 cases the whole of the right lung was drained into the inferior vena cava, in one of these

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Symptoms There were no symptoms in 21 cases Twenty cases had s with *predominance of moderate dyspnoea on exertion* Some cases evidence of palpitation, haemoptysis, or recurrent respiratory i None of the cases had severe incapacity attributable to the malforma

Conclusions

An anomalous venous connection is not a frequent malformation, generally well tolerated The anomalous drainage *proceeds always* right lung There is dextroposition of the heart in many cases The h namic alteration that this malformation produces is that of a lef shunt similar to that of ASD, but of lesser magnitude This may be by the difference in the vascularity of the two lungs and the thoracic asy

SUMMARY

The authors describe a case of a partial anomalous venous connection of a ver that drained the whole of the right lung into the inferior vena cava and analyse a *cases described in the literature The relation of dextroposition of the heart observ* of these cases with the sites of connection of the anomalous vein with the inferior is described Haemodynamic alterations produced by the malformation are consider

ZUSAMMENFASSUNG

Die Verfasser beschreiben einen Fall mit einer partiellen anormalen venosen Ve eines venosen Stammes welche die ganze rechte Lunge in die Vena cava inferior Weitere 45 Falle aus der Literatur werden analysiert Die Beziehung der Rechtsve des Herzes welche man in einigen dieser Fallen beobachtet hat zu den Stellen der Ve der anormalen Vene mit der Vena cava inferior wird beschrieben Hamodynami anderungen welche durch die Missbildung erzeugt sind werden beschrieben

RÉSUMÉ

Les auteurs decrivent un cas de connection veineuse partielle anormale ou un tron drainait la totalité du poumon droit dans la veine cave inférieure et ils en analysent cas décrits dans la littérature *Ils examinent la relation entre la dextroposition du c* servée dans certains de ces cas et le lieu d abouchement des veines anormales dans cave Ils étudient les troubles hémodynamiques dus à ces malformations

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DIE WANDVERKALKUNG DES LINKEN VORHOFS IM RÖNTGENBILD

von

H ANDERSCH, A STECKEN und H WITTE

Vorhofwandverkalkungen (Abb 1) gelten im Schrifttum als ausgesprochene Seltenheiten und wurden bisher fast ausschließlich in Vergesellschaftung mit einem Mitralvitium beobachtet Vor drei Jahren konnten wir (JÜRGENS STECKEN & WITTE) über vier eigene Fälle unter Berücksichtigung weiterer 39 aus der uns zugänglichen Literatur berichten Inzwischen publizierten MAHONEY & O LOUGHLIN (1959) zwei Vitien mit einem ähnlichen Befund In einem dieser Fälle konnte post mortem die Diagnose erhärtet werden Im gleichen Jahr veröffentlichten VICKERS KINCAID ELLIS & BRUWER weitere fünf linke Vorhofwandverkalkungen wovon vier durch die Operation bestätigt wurden Bei drei Patienten lag außerdem eine zusätzliche Verkalkung der Mitralklappe vor Ein Jahr später teilten SVOBODA & SOBOTKOVÁ sowie MANECKE je einen weiteren Fall mit Da bei der Patientin des letzten Autor neben einem Aorten Mitralvitium noch ein Marfan Syndrom bestand und eine rheumatische Affektion in der Krankengeschichte fehlte wurde die Vorhofwandverkalkung auf „einen Defekt im mesodermalen Gewebe zurückgeführt BAEYENS und Mitarbeiter konnten ebenfalls 1960 eine murale Atriumkalzifikation bei einem 59 jährigen Patienten durch die Tomographie des Herzschattens nachweisen

Berücksichtigt man diese Mitteilungen in der Weltliteratur so ist man geneigt diesen Befund als ausgesprochene Rarität anzusehen da bisher nur etwa 50 Fälle bekannt wurden In der europäischen Literatur findet die Wandver

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Vorhofwandverkalkungen (Abb. 1) gelten im Schrifttum als ausgesprochene Seltenheiten und wurden bisher fast ausschließlich in Vergesellschaftung mit einem Mitralvitium beobachtet. Vor drei Jahren konnten wir (JÜRGENS, STECKEN & WITTE) über vier eigene Fälle unter Berücksichtigung weiterer 39 aus der uns zugänglichen Literatur berichten. Inzwischen publizierten MAHONEY & O'LOUGHLIN (1959) zwei Vitien mit einem ähnlichen Befund. In einem dieser Fälle konnte post mortem die Diagnose erhärtet werden. Im gleichen Jahr veröffentlichten VICKERS, KINCAID, ELLIS & BRUWER weitere fünf linke Vorhofwandverkalkungen, wovon vier durch die Operation bestätigt wurden. Bei drei Patienten lag außerdem eine zusätzliche Verkalkung der Mitralklappe vor. Ein Jahr später teilten SVOBODA & SOBOTKOVÁ sowie MANECKE je einen weiteren Fall mit. Da bei der Patientin des letzten Autors neben einem Aorten-Mitralvitium noch ein Marfan-Syndrom bestand und eine rheumatische Affektion in der Krankengeschichte fehlte, wurde die Vorhofwandverkalkung auf einen Defekt im mesodermalen Gewebe zurückgeführt. BAEYENS und Mitarbeiter konnten ebenfalls 1960 eine murale Atriumkalzifikation bei einem 59jährigen Patienten durch die Tomographie des Herzschattens nachweisen.

Berücksichtigt man diese Mitteilungen in der Weltliteratur, so ist man geneigt, diesen Befund als ausgesprochene Rarität anzusehen, da bisher nur etwa 50 Fälle bekannt wurden. In der europäischen Literatur findet die Wandver-

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Abb. 1. 45 jährige Patientin mit kombiniertem Mitralvitium bei überwiegender Stenose (Herzkatheterisierung) sowie Zeichen einer Tricuspidalinsuffizienz. Im a. p. Tomogramm Nachweis einer schaligen linken Vorhofwandverkalkung, der in Höhe des linken Herzohres eine schollige Verdichtung aufsitzt (verkalkter Thrombus)

kalkung selbst in größeren umfassenden Arbeiten über Mitralfehler kaum eine Erwähnung. Die bisher größte Beobachtungszahl eines Instituts von fünf Fällen stammt aus der Mayo Klinik (VICKERS, KINCAID, ELLIS & BRUWER).

Eigene Erfahrungen. In starker Diskrepanz zu dieser geringen Zahl der Weltliteratur stehen unsere eigenen Erfahrungen. Im Verlaufe der letzten fünf Jahre konnten wir allein 10 Fälle unter etwa 500 Mitralvitien diagnostizieren. Das ist nach unseren Beobachtungen eine Häufigkeit von 2 % bei diesem Herzfehler und damit ein Faktor, der es verdient, eine stärkere Beachtung zu finden. Nur in einem weiteren Fall fehlte eine rheumatische Genese und der Befund eines Mitralfehlers.

Die Erklärung für die Seltenheit von entsprechenden Hinweisen in der Literatur ist wahrscheinlich darin zu suchen, dass die gewöhnlichen Übersichts



b

Abb 2 55 jährige Patientin Vorwiegende Mitralstenose geringe Aortenstenose (Bestätigung durch Sektion) a) In der linken Vorhofwand erscheint auf dem Hartstrahlbild eine schalige Verkalkung b) Tomogramm in 12 cm Schichttiefe Die Verkalkung ist tomographisch eindeutiger zu erkennen Gleichzeitig angedeutete zarte schalige Kalzifikation am rechten Rand des linken Vorhofs

aufnahmen nicht unter den Bedingungen der Hartstrahltechnik hergestellt werden Bei Durchleuchtung mit einer Spannung über 100 Kilovolt und eingeblendetem Feld oder mit dem Bildverstärker ist die Verkalkung unter Umständen besser zu erkennen (Abb 2a) Am zuverlässigsten hat sich uns zu ihrer Darstellung die Tomographie in zwei Ebenen bewährt (Abb 2b)

Wir sind der Meinung daß die relativ große Zahl unserer Beobachtungen nur dadurch gewonnen wurde weil wir bei der gezielten Untersuchung eines Vitiums mit Nativmethoden routinemäßig eine Simultanschichtuntersuchung in zwei Ebenen anwenden Auf diese Weise können selbst gering ausgeprägte sehr zarte Kalkschalen (Abb 6) oder umschriebene Verkalkungen von wandständigen Thromben (Abb 4) sowohl in den Seitenwänden wie auch an der Hinterwand erfaßt werden

Pathologisch anatomisch unterscheidet man zwischen einer schalenförmigen Kalkablagerung in der subendothelialen Schicht der linken Vorhofwand (Abb 3) und verkalkten wandständigen Thromben (Abb 4) Die letzteren sind im allgemeinen rundlich halbmondförmig oder lamellar gestaltet Es gibt Kombinationsfälle so daß röntgenologisch diese Unterscheidung schwierig oder unmöglich sein kann



Abb. 3. 63jährige Patientin. Tomographischer Nachweis einer schalenförmigen Verkalkung im linken Herzohr bei einem kombinierten Mitral-Aortenvitium mit wahrscheinlicher relativer Tricuspidalinsuffizienz.

Neben der unterschiedlichen Form und Genese der Verkalkung ist auf eine unterschiedliche Lokalisation hinzuweisen. Die Kalzifikation kann zusammenhängend fast das gesamte Endothel befallen, wie es von SVOBODA beschrieben wurde. In Abb. 5 liegt ein ähnlich ausgedehnter Befund vor, der die ganze Hinterwand des linken Vorhofs betroffen hat. Sie kann aber auch schalig an umschriebener Stelle (Abb. 6) oder schollig fleckig auftreten. Die Verkalkungen des linken Herzohres und der Seitenwand sind am besten im anterior-posterioren (Abb. 1, 2b und 3), Verkalkungen der kranialen und dorsalen Wand besser im seitlichen Strahlengang (Abb. 5 und 6) zu erfassen. Eine gleichzeitige kalzifizierende Mitralklappenveränderung konnten wir in drei von den 10 Fällen feststellen.

Differentialdiagnostisch *ist von der Vorhofwandverkalkung, die im Endokard* oder in dem Endokard angelagerten Thromben lokalisiert ist, die verkalkte Perikardschwiele abzugrenzen. Dies gelingt im allgemeinen bei der



Abb. 4. 30jährige Patientin mit reiner Tricuspidal- und Mitralinsuffizienz. a) Tomogramm in 7 cm Schichttiefe. *In den riesig erweiterten linken Vorhof* projiziert sich eine umschriebene rundliche Verdichtung, die als Thrombusverkalkung gedeutet wurde (Bestätigung durch Sektion). b) Im linksseitlichen Tomogramm ist die Thrombusverkalkung an der Hinterwand lokalisiert.

rotierenden Durchleuchtung durch den Nachweis der unterschiedlichen Lo*kalisation*, da die Einlagerung in der Vorhofwand niemals randständig ist. Gelegentlich ist auch an eine Verkalkung von Geschwulsten, besonders *von* Myxomen des Herzens zu denken. Koronarverkalkungen dürften ihrer Form und *ihrem* Verlauf nach (LAWES) im Schichtbild nur selten diagnostische Schwierigkeiten bereiten.

Eine besondere Erörterung verdient die Frage, ob linke Vorhofwandverkalkungen *auch* ohne eine vorausgegangene rheumatische Endokarditis vorkommen können. MANECKE wies auf die Möglichkeit einer kausalen Relation zum Marfan-Syndrom hin. In seinem Fall lag aber auch ein Aorten-Mitralvitium mit *einer entsprechenden* Herzumformung und mit Vorhofflimmern vor. Eine rheumatische *Anamnese* bestand dagegen nicht. Es sind aber sichere rheumatische Vitien ohne eine entsprechende Vorgeschichte bekannt, so daß diese Frage unseres Erachtens offen bleiben muß.

Auch in unserem 11. Fall lag bei einer 68jährigen Patientin keine rheumatische Vorgeschichte vor. *Elektrokardiographisch* war kein Vorhofflimmern nachzuweisen. Klinisch wurde wegen eines systolischen Geräusches über der Aorta an eine Aortenstenose *gedacht*. Röntgenologisch zeigte der linke Ventrikel eine mäßige Vergrößerung. Wenn *man* ein früh erworbenes rheumatisches Vitium unterstellt, müßte man bei dem Alter eine stärkere Umformung des Herzens erwarten.



Abb. 5. 39jähriger Patient mit prävalierender Mitralinsuffizienz und Tricuspidalinsuffizienz. Im linksseitlichen Tomogramm ist die Hinterwand des linken Vorhofs durch eine Kalkschale markiert



Abb. 6. 30jähriger Patient. Dreiklappenvitium mit vorwiegender Insuffizienz. Im linksseitlichen Schichtbild ist in Höhe des linken Herzohres eine zarte strichförmige Verkalkung nachzuweisen

Sowohl auf der Hartstrahlaufnahme wie auf dem Kymogramm ließen sich im Bereich der Aortenwurzel und der linken unteren Vorhofregion Verkalkungen nachweisen, die im linksseitlichen Tomogramm (Abb. 7) noch eindeutiger zu differenzieren und lokalisieren sind. Man erkennt etwa in der Gegend der Aortenbasis eine ringförmig angeordnete schollige Verkalkung und vier Zentimeter davon in dorsokaudaler Richtung entfernt eine weitere schalige Kalzifikation. Diese mußte lagemäßig der unteren Hinterwand des nicht vergrößerten linken Vorhofs angehören (siehe auch Abb. 5). Gleichzeitig ist eine ungewöhnliche Verkalkung des Arcus aortae, der A. carotis communis sinistra und der Descendens zu erkennen.

Da klinisch und röntgenologisch kein Hinweis für ein Mitralvitium besteht, keine rheumatische Anamnese und kein Vorhofflimmern vorliegt, weicht dieser Fall erheblich von den bisher bekannten Fällen einer linken Vorhofwandverkalkung ab. Im Rahmen der ausgedehnten Verkalkungen an der Aorta und dem Alter des Patienten ist zu diskutieren, ob es sich um eine primäre degenerative Sklerose handelt. Diese Entwicklung ist, wenn auch selten, im Bereich des Klappenapparates bekannt. In diesem Sinne konnte auch die ringförmige Verkalkung im Bereich der Aortenwurzel gedeutet werden. Bekanntlich be-



Abb. 7. 68jährige Patientin ohne rheumatische Anamnese und Mitralvitium. Schollige Verkalkung im linksseitlichen Schichtbild in Höhe des Aortenursprungs (primär degenerative Sklerose des Klappenapparates?). Derbe schalige Verkalkung in der *Regio* des unteren Abschnittes der Hinterwand des linken Vorhofs. Ausgedehnte Verkalkung der Aorta.

ginnen diese Veränderungen im Gegensatz zu den rheumatischen Vitien an der Basis des Klappenapparates.

Die Frage der klinischen Bedeutung einer Vorhofwandverkalkung bei einem Mitralvitium interessiert sowohl den Kliniker wie den Herzchirurgen. Unter Berücksichtigung der Angaben aus den bisherigen Mitteilungen, die sich mit unseren Erfahrungen decken, sind folgende klinische Besonderheiten zu erwähnen:

1. Es besteht nach den bisher bekannten Fällen fast ausschließlich eine rheumatische Genese dieser Verkalkungen.

Tabelle

	Alter/ Geschlecht Jhr.	Rheumatismus	Herzbeschwerden seit Jhr.	Vorhofflimmern im EKG seit Jhr.	Mitralvitium	Anderer Klappenbefall	Sitz der Verkalkung	Mitralklappenverkalkung	Bestätigung durch
1	30 ♀	+	17	6	reine Insuffizienz	Tricuspidal-insuffizienz	dorsale Wand (Thrombus)	—	Sektion
2	42 ♀	+	15	8	vorwiegende Stenose	—	Herzohr (Thrombus)	+	—
3	40 ♀	+	23	5	vorwiegende Stenose	Tricuspidal-insuffizienz	dorsale u. kaudale Wand (*Thrombus*)	—	—
4	20 ♀	+	4	1	vorwiegende Insuffizienz	Tricuspidal-insuffizienz	ventr. und kaudale Wand (Thrombus)	+	Operation
5	46 [illegible]	+	25	20	vorwiegende Insuffizienz	—	dorsale und kaudale Wand (Thrombus)	+	—
6	30 ♂	+	16	9	vorwiegende Insuffizienz	Aorten-, Tricuspidalinsuffizienz	kraniale u. kaudale Wand	—	Sektion
7	55 [illegible]	+	40	12	vorwiegende Stenose	*Aortenstenose*	*kraniale*, dorsale u. kaudale Wand	—	Sektion
8	63 ♀	+	46	16	kombiniert	Aortenstenose, Tricuspidal-insuffizienz	Herzohr	—	—
9	39 ♂	+	17	5	kombiniert	Tricuspidal-insuffizienz	kaudale Wand und Herzohr	—	—
10	45 [illegible]	+	12	10	kombiniert	Tricuspidal-insuffizienz	kraniale Wand und Herzohr	—	—
11	68 ♀	—	1	—	—	Primär degenerative Aortenklappenverkalk.	kaudale Hinterwand	—	—

2. Fast immer ist eine längere Zeit bestehendes *Vorhofflimmern* nachzuweisen.

3. *Häufig ist* gleichzeitig eine stärkere Insuffizienzkomponente vorhanden, so daß nach unseren Erfahrungen die Operationsindikation besonders sorgfältig zu stellen ist.

4 Sehr oft ist ein Befall anderer Herzklappen zu verzeichnen

Aus der tabellarischen Übersicht unserer 10 Falle, Seite 318 sind diese klinischen Besonderheiten zu er ehen Nach dieser Übersicht handelt es sich, wenn man von dem 11 Fall ohne Mitralvitium absieht um sechs Frauen und 4 Manner Das Alter der Patienten lag zwischen dem 20 und 63 Lebensjahr Am haufigsten konnte die Verkalkung im 4 (drei Falle) und 5 (vier Falle) Lebensjahrzehnt beobachtet werden Nur in drei Fallen war eine uberwiegende Stenose in allen anderen ein kombiniertes Mitralvitium oder eine uberwiegende bzw eine reine Insuffizienz vorhanden Achtmal wurde ein Mehrklappenbefall nachgewiesen In drei Fallen konnte die Diagnose durch die Sektion bestatigt werden

Fur den Chirurgen ist bei einer eventuellen Operationsindikation die praeoperative Kenntnis einer solchen Vorhofwandverkalkung besonders wichtig, da bei entsprechender Lokalisation der ubliche transaurikulare Weg zur Klappensprengung nicht gangbar ist Der Operationsmodus uber einen transvenosen Zugang ist aber mit einer hoheren Mortalitat, also mit einem großeren Operationsrisiko verbunden

Schlußbetrachtung

Abschließend und zusammenfassend ist zu den Fragen der Haufigkeit der Darstellung und der klinischen Bedeutung von Wandverkalkungen des linken Vorhofs folgende Schlußfolgerung zu ziehen

1 Die Verkalkung der linken Vorhofwand ist offenbar nicht so extrem selten wie es nach der Literatur den Anschein hat

2 Die rontgenologische Darstellung erfordert die Wahl eines Untersuchungsverfahrens das geeignet ist die innerhalb des Herzschattens gelegene Verkalkung zu erkennen Dabei hat sich nach unseren Erfahrungen am besten die Tomographie bewahrt

3 Bei Vorliegen von Vorhofwandverkalkungen besteht im allgemeinen eine typische Symptomatik mit rheumatischer Genese Vorhofflimmern oft kombiniertem Mitralvitium mit bedeutsamer Insuffizienzkomponente der Mitralis und Verdacht auf Mehrklappenbefall

Umgekehrt sollte der Rontgenologe bei dieser Symptomatik an die Moglichkeit einer Vorhofwandverkalkung denken Auf die Wichtigkeit der praeoperativen Kenntnis ist besonders hinzuweisen

Eine Vorhofwandverkalkung ohne Mitralvitium ist selten

ZUSAMMENFASSUNG

Es wird uber 10 Falle einer linken Vorhofwandverkalkung unter etwa 500 Mitralvitien berichtet Berucksichtigung finden Fragen der Haufigkeit dieses Vorkommens der rontgenologischen Darstellung und der klinischen Symptomatik Nur in einem weiteren Fall lag bei einer Vorhofwandverkalkung keine rheumatische Anamnese und kein Mitralvitium vor

SUMMARY

Ten cases of calcification of the wall of the left auricle were encountered in a material of about 500 cases of mitral disease The frequency of this condition the method of roentgen ologic investigation as well as the clinical features are discussed Only in one further case of such calcification was there no history of rheumatic fever or evidence of mitral disease

RÉSUMÉ

Sur environ 500 cas d affections mitrales l auteur presente 10 cas de calcification de la paroi de l oreillette gauche Il étudie leur fréquence leur mise en évidence radiologique et leur symptomatologie clinique Dans un seul et onzieme cas le calcification de la paroi de l oreillette était sans antecédents de rhumatisme ou d *affection mitrale*

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LOW SUBVALVULAR AORTIC AND PULMONIC STENOSIS WITH HYPERTROPHY AND ABNORMAL ARRANGEMENT OF THE MUSCLE BUNDLES OF THE MYOCARDIUM

by

B NORDENSTROM and C O OVENFORS

Infundibular stenosis of the right ventricle is generally due to hypertrophy of the septal and parietal bands and the supra ventricular crista Subvalvular tenosis of the left ventricle is usually caused by a fibrous ring with thickening of the endocardium In addition a muscular band may sometimes take part in the stenosis (GRUENWALD 1947)

In recent years a previously unknown type of low subaortic stenosis has been observed TEARE (1958) who described the pathologic anatomy used the term asymmetric hypertrophy of the heart The condition is caused by a localized hypertrophy of the ventricular septum and is characterized micro scopically by a coarse texture with bizarre arrangements of bundles of muscle fibres separated by connective tissue and clefts In one of TEARE's cases the anterior wall of the left ventricle was mainly involved and the mitral orifice was also constricted HOLLMAN et coll (1960) have described similar cases with obstruction of the tricuspid orifice The most common localization however, seems to be the ventricular septum with constriction of the outflow tracts both of the right and left ventricle (NEUFELD, ONGLEY & EDWARDS 1960)

From the Roentgen Department (Director Bjorn Nordenstrom) Thoraxkliniken Karolinska sjukhuset Stockholm Sweden Submitted for publication 10 January 1962

SUMMARY

Ten cases of calcification of the wall of the left auricle were encountered in a material of about 500 cases of mitral disease The frequency of this condition the method of roentgenologic investigation as well as the clinical features are discussed Only in one further case of such calcification was there no history of rheumatic fever or evidence of mitral disease

RÉSUMÉ

Sur environ 500 cas d affections mitrales l auteur présente 10 cas de calcification de la paroi de l oreillette gauche Il étudie leur fréquence leur mise en évidence radiologique et leur symptomatologie clinique Dans un seul et onzieme cas le calcification de la paroi de l oreillette était sans antécédents de rhumatisme ou d affection mitrale

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Fig 1 Case 1 Considerable enlargement of the left atrium and left ventricle Right ventricle probably also enlarged Aorta and main trunk of pulmonary artery normal Basal pulmonary vessels slightly narrowed

In Case 1 contrast medium was injected through a Teflon catheter introduced in a retrograde direction into the left ventricle and in Case 4 through a catheter placed in the left atrium by the transseptal technique

Results

The size of the heart the relative enlargement of the heart chambers as judged from conventional films and the appearance of the central and basal pulmonary arteries as well as of the aortic arch are given in the Table It is evident that considerable cardiac enlargement was present in the first two cases In Case 3 there was no definite general enlargement of the heart but in Cases 4 to 8 moderate enlargement was present Left ventricular enlargement was considered to be present in all the cases and left atrial enlargement in all cases with exception of Case 3 The relative size of the right ventricle or right atrium was difficult to estimate Enlargement of the right ventricle as well as the right atrium was however considered to be probable in Cases 1 2 6 and 7 There was also a widening of the central pulmonary arteries with a relative narrowing of the peripheral basal pulmonary arteries of both lungs in these case Such pulmonary vascular changes are often present in cases with pressure elevation in the left atrium and the pulmonary veins for a relatively long period These changes were considered to be present in Case 4 which is remarkable in that there was no obvious enlargement of the left atrium On the other hand no such alterations were evident in the pulmonary vessels in Case 5 which had a

Table

Heart volume determinations and findings at conventional roentgen examinations

Case	Heart volume			Enlargement		Enlargement		Pulmonary arteries		Aortic arch enlargement or narrowing
	Recumbent ml total	Erect ml total	Ml/m² body surface	Right atrium	Right ventricle	Left atrium	Left ventricle	Central dilatation	Basal narrowing	
1	1 650	1 350	800	+	+	++	+++	+	+	0
2	1 220	1 280	820	+	+	++	+++	+	+	0
3	—	770	450	0	0	0	++	0	0	0
4	1 130	1 080	590	0	0	+	+	+	+	0
5	1 240	1 210	680	0	0	++	+++	0	0	0
6	1 280	1 080	550	+	+	+	++	+	+	0
7	1 045	1 000	600	+	+	++	+++	+	+	0
8	970	860	510	0	+	++	++	0	0	0

Roentgenologic observations were made by GOODWIN et coll (1960) who described 9 cases with increased heart size in 7, the left atrium was enlarged in all these seven cases, the right atrium in six, and the left ventricle in five cases the aorta was *thought to have a smaller calibre than normal* in six cases

Cardioangiography was performed in 2 cases reported by GOODWIN et coll and in 9 cases published by BRAUNWALD et coll (1960) The present paper is concerned with the roentgenologic findings in 8 cases with morphologic changes in the heart bearing a close resemblance to TEARE s cases The clinical and hemodynamic findings in these cases will be reported elsewhere by BEVEGARD, JONSSON & KARLOF (1962)

Methods The heart volume was determined both in the erect position (JONSELL 1939) during inspiration and in the recumbent prone position (LARSSON & KJELLBERG 1948) with films exposed during quiet breathing

Cardioangiography was performed in the supine position with a bi plane serial film changer (Elema) at a speed of 3 pairs of exposures per second during simultaneous recording of ECG, contrast injection and exposure marking The contrast medium, Urografin 76 % was injected into the right ventricle or atrium via a so called 'recoil free catheter (NORDENSTROM 1954) and a Gidlund syringe (Elema)

Injection *of the contrast medium into the left ventricle was performed after* transthoracic puncture (KJELLBERG et coll 1961) in Cases 1, 2, 5, 6 and 7

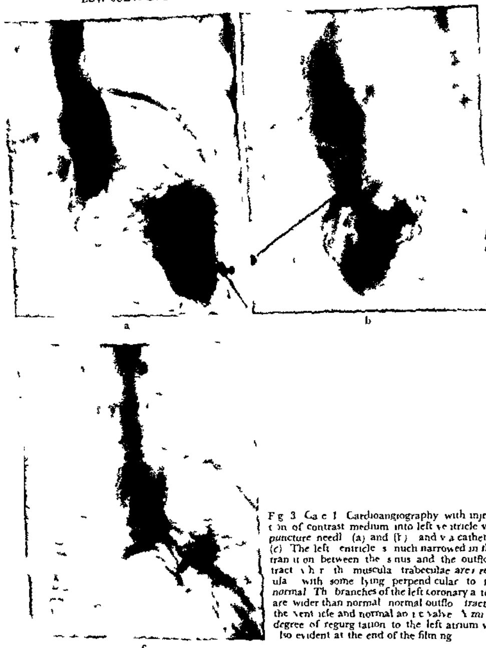


Fig 3 Case 1 Cardioangiography with injection of contrast medium into left ventricle via *puncture* needle (a) and (b) and via catheter (*c*) The left ventricle is much narrowed *in the* transition between the sinus and the outflow tract where the muscular trabeculae *are irregular* with some lying perpendicular to the *normal* The branches of the left coronary artery are wider than normal normal outflow *tract of* the ventricle and normal aortic valve A *minor* degree of regurgitation to the left atrium was also evident at the end of the filming

left ventricle appeared to be displaced in a cranial and lateral direction (Fig 5) The pathologic changes in all the cases were less marked in the apical part of the left ventricle The papillary muscles were substantially thickened



a b

Fig 2 Case 2 Enlargement of probably both the right and left ventricle and left atrium The left cardiac border is tortuous the pulmonary vessels are unchanged and the aorta is slightly tortuous but not widened

definitely enlarged left atrium and ventricle No definite aortic arch enlargement or narrowing was found in any of the cases

No calcium deposits could be detected within the heart or in the pericardium in any of the cases at fluoroscopy and cinefluorography

Cardioangiography with injection of contrast medium *into the left ventricle* under general anesthesia was performed in Cases 1, 2, 5, 6 and 7 (Figs 3, 5, 9, 11 and 13) *In all these cases the ventricular wall was considerably thickened* and irregular indentations in the lumen of the left ventricle were evident The thickening, which was most marked at the borderline between the conus and sinus part of the ventricle, 4 to 5 cm below the aortic valves caused the lumen of the left ventricle to appear divided into two parts This was most prominent during ventricular systole (Fig 5) In Cases 1, 2 5 and 6 the left ventricular wall between the conus and sinus part bulged into the lumen of the left ventricle as a broad band like indentation and, in this region, some of the trabeculi were arranged in a direction perpendicular to that usually seen in a normal left ventricle This was particularly marked in Case 1 (Fig 3c) A comparison of the cardioangiograms from the left and right ventricles disclosed that the interventricular septum was much thickened and bulged into the lumen on both sides (Figs 3, 4 5, 6, 8, 12 and 14) The lumen of the



Fig. [illegible] Case 2 Cardioangiography with injection into the left ventricle which has a considerably thickened wall The septum and the papillary muscles and the cranial part lateral to the outflow tract are in the main thickened The thickened papillary muscles protrude deeply into the sinus part (b) The mitral valves are displaced cranially during ventricular systole The aortic valves and the outflow tract of the ventricle are unchanged (a) and (b) (b) was exposed one sixth of a second after (a) During ventricular diastole (c) the slightly curved mitral valve can be seen a massive reflux to the enlarged left atrium has occurred The coronary arteries are very wide on both sides

pathologic pattern of contraction in the left ventricular wall This was most evident in Case 2 and was mainly characterized by a considerable local contraction between the subvalvular region and the sinus part of the left ventricle during ventricular systole The observations were made while no extra systoles occurred

In Case 2 the mitral valve showed a slightly irregular border during diastole and a moderate amount of contrast medium regurgitated to the left atrium

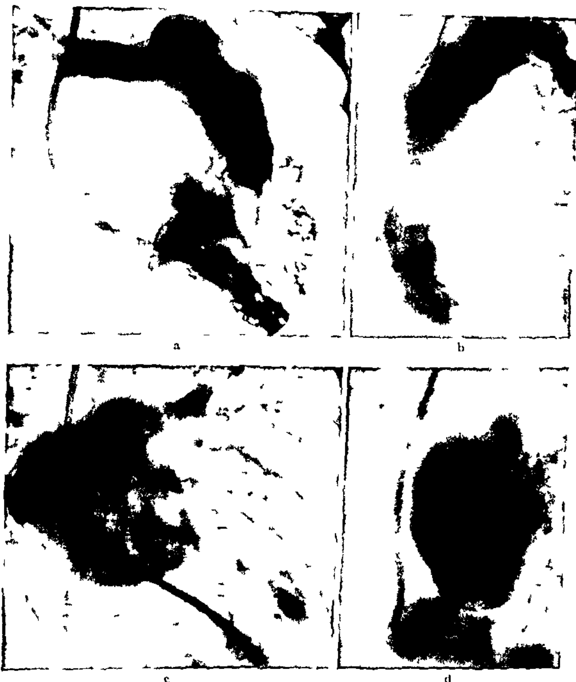


Fig 4 Case 1 Cardioangiography with injection into the right ventricle a) The right ventricle is displaced to the left and compressed antero posteriorly its anterior wall is moderately thickened and richly trabeculated The sinus part and the outflow tract of the pulmonary artery are moderately narrowed b) The left atrium is enlarged Note the difference in width basally and cranially of the pulmonary veins

in Case 2 The conus part of the left ventricle and the aortic valves appeared to be normal in every case

Analysis of the sequence of films obtained at cardio angiography revealed a



Fig 7 Case 3 Cardiangiographs with injection into the right ventricle The lumen of the right ventricle compressed from the left side (a and slight stenosis present between the sinus and the outflow tract of the pulmonary artery The left atrium (c) and (d) enlarged and empties slowly The lumen of the left ventricle deformed by a thickening mainly of the septum and the frontal part of the ... wall

The *left coronary artery* was considerably widened in Cases 1, 2 5 and 6 In Cases 1 and 5 the anterior descending branch of the left coronary artery was displaced anteriorly and to the left the displacement corresponding to local hypertrophy of the interventricular septum In Case 2 the right coronary

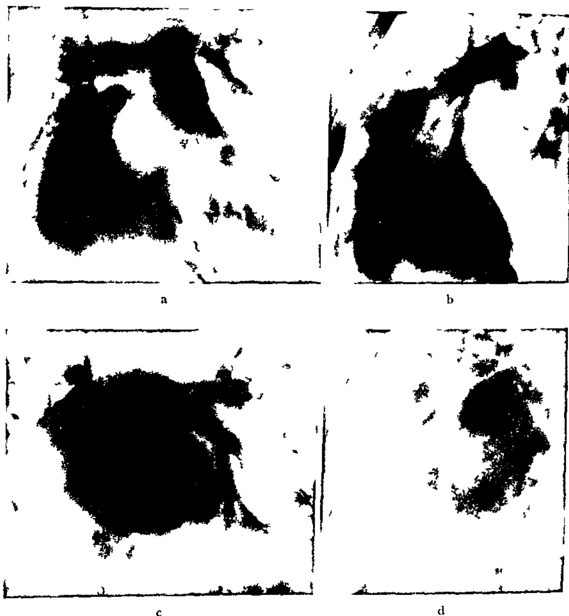


Fig 6 Case 2 Cardioangiography with injection into the right atrium which is moderately enlarged Marked rounded compression of the sinus part of the right ventricle No valvular or ordinary infundibular stenosis is present The outflow tract of the right ventricle is considerably narrowed (a) After the passage of the contrast medium through the lesser circulation an enlarged left atrium is evident (c) and (d)

during systole The regurgitation could not be explained only by extra systoles occurring during the injection of contrast medium, and a part of it was evidently due to a slight incompetence of the mitral valve A small degree of insufficiency of the mitral valves was also detected in Cases 1 and 6

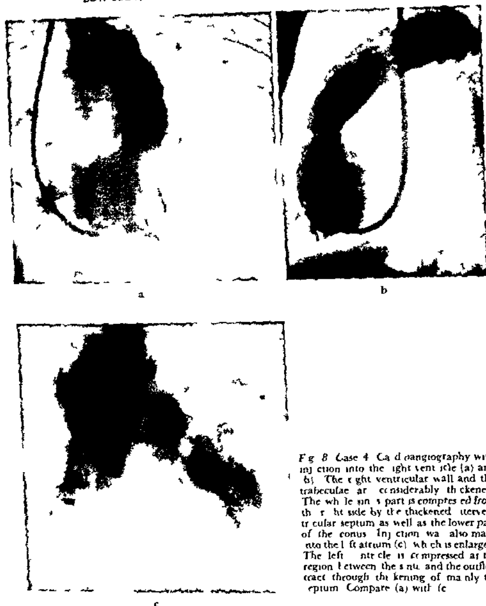


Fig 8 Case 4 Cardioangiography with injection into the right ventricle (a) and (b). The right ventricular wall and the trabeculae are considerably thickened. The whole sinus part is compressed from the right side by the thickened interventricular septum as well as the lower part of the conus. Injection was also made into the left atrium (c) which is enlarged. The left ventricle is compressed at the region between the sinus and the outflow tract through thickening of mainly the septum. Compare (a) with (c).

papillary muscles the lumen was considerably narrowed and part of the muscle in this region was resected. The patient died three days after the operation. Microscopic examination of the resected tissue from both cases disclosed hypertrophic heart muscle with interstitial fibrosis.

artery was considerably widened, probably as a consequence of marked right ventricular hypertrophy, this was subsequently confirmed at cardioangiography with contrast injection into the right ventricle

The ascending aorta was normal in size in Cases 1, 2, 3, 4, 7 and 8 In Cases 5 and 6, however, the ascending aorta was slightly widened, this widening suggested a generally enlarged aorta and might have been explained by these patients' occupation which had included a great deal of heavy physical exertion The enlargement of the ascending aorta had not the appearances commonly seen in cases of valvular aortic stenosis

Contrast injection into the *right atrium* was performed in Case 2 (Fig 6) and into the *right ventricle* in Cases 1, 3, 4, 5, 7 and 8 (Figs 4, 7, 8, 10, 12 and 14) The right ventricle revealed a variable degree of compression from the left together with displacement mainly due to thickening of the interventricular septum in all these cases In Cases 3 and 4 (Figs 7 and 8) the conus appeared to be nearly normal but the interventricular septum produced a moderate bulging into the lumen of the ventricle In Case 4 (Fig 8) there was also compression of the sinus part of the right ventricle Pressure recording with a catheter revealed a considerable pressure gradient between the conus and valvular regions and marked enlargement of the right atrium was also present in this case Obvious narrowing between the sinus and the outflow regions of the right ventricle was also evident in Cases 1, 5, 7 and 8 (Figs 4, 10, 12 and 14), but only in Cases 7 and 4 was there a pressure gradient In these cases the stenosis was caused by an elongated bulging of the interventricular septum at the level of the ostium infundibuli, and consequently without the appearances of the usual infundibular stenosis Valvular pulmonic stenosis was not present in any of the cases

The basal branches of the pulmonary arteries were narrowed in Cases 1, 2, 4, 6 and 7 as had been observed in the conventional films There was also some widening of the central pulmonary arteries After the passage of the contrast medium through the pulmonary vessels it was possible to verify the enlargement of the left atrium and ventricle as evident in the conventional films The most marked enlargement was present in Cases 1, 2, 3 and 8 (Figs 4, 6, 7 and 14)

Operation (under extra corporeal circulation) was performed in two cases (Cases 2 and 6) The ascending aorta was opened in Case 2 No valvular or subvalvular stenosis was palpable but following incision of the right ventricle the previously evident constriction of the lower part of the right ventricular outflow region, due to the hypertrophy of the interventricular septum became apparent Part of the muscle of the interventricular septum was resected in an attempt to remove the obstruction to the flow but the patient died five days later In Case 6, palpation from the aorta disclosed a normal width of the outflow tract of the left ventricle, more apically, however, close to the



Fig 10 Case 5 Cardioangiography with injection into right ventricle Reflux of medium to the right atrium The right ventricle is displaced to the right and the sinus part is compressed by the thick n d in ventricular septum Narrowing evident between the sinus and the outflow tract After the medium has passed through the pulmonary vessels the left atrium is seen to be somewhat enlarged

Discussion

The clinical picture of this heart condition as pointed out by BEVEGARD et coll (1962) seems to be so characteristic that a fairly accurate diagnosis may be made in most cases by physical examination electrocardiography and ordinary roentgen examination although in some cases it is impossible Heart catheterization with pressure recordings will not necessarily differentiate this type of malformation from an ordinary type of stenosis in the outflow region of the right ventricle or the subvalvular region of the left ventricle The diagnosis is obtained by cardioangiography Since both ventricles may be involved, it

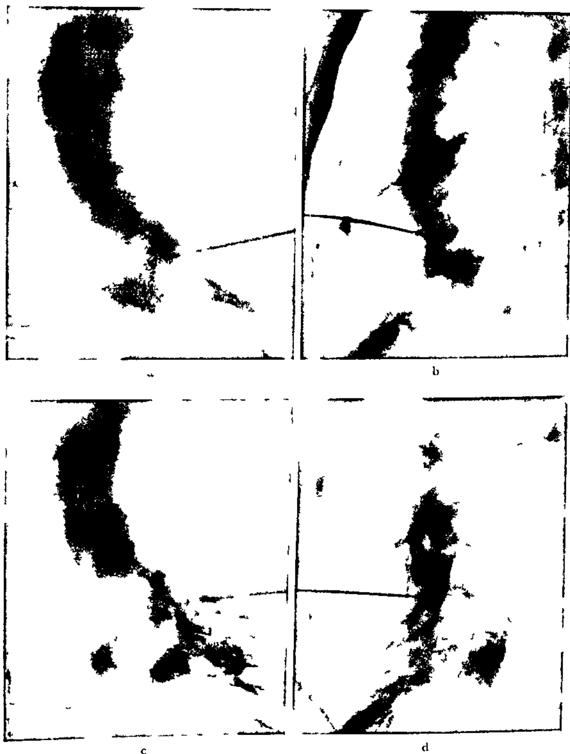


Fig 9 Case 5 Cardioangiography with injection into the left ventricle Marked indentations between the sinus and the outflow tract Very thick interventricular septum No changes evident in the aortic valves The ascending aorta is slightly widened During systole (a) and (b) marked local narrowing appears in the transition between the sinus and the outflow tract of the left ventricle The coronary arteries are considerably wider than normal especially on the left side



Fig 12 Case 7 Cardioangiography with injection into right ventricle Moderate compression of the right ventricle from the thickened interventricular septum without any marked stenosis of the outflow tract Left atrium is slightly enlarged and left ventricle compressed in the sinus part mainly due to thickening of the septum

mitral valve The anterior mitral leaflet in such a case will then move forward against the anterior part of the outflow region of the left ventricle and produce a sharp but irregular indentation in the contrast medium The band like formations in the outflow region of the left ventricle that were found in Cases 5 and 6 were probably caused by the mitral valve It is remarkable that quite normal mitral valves were found at autopsy in the subjects of Cases 2 and 6 who died following operation

The hypertrophic wall of the left ventricle with its irregularly arranged trabeculae seems to contract in an abnormal manner to cause a concentric

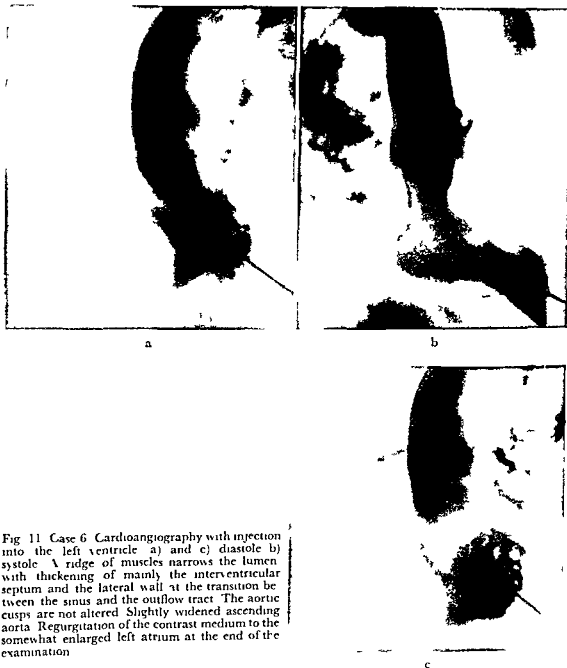


Fig 11 Case 6 Cardioangiography with injection into the left ventricle a) and c) diastole b) systole A ridge of muscles narrows the lumen with thickening of mainly the interventricular septum and the lateral wall at the transition between the sinus and the outflow tract The aortic cusps are not altered Slightly widened ascending aorta Regurgitation of the contrast medium to the somewhat enlarged left atrium at the end of the examination

is preferable, although not always necessary, to perform the injection of contrast medium in both the right and the left ventricles

Hypertrophy of the heart muscle may afford a reasonable explanation for the increased size of the coronary vessels that was present in our cases The 'membrane like' narrowing of the subvalvular region of the left ventricle that was seen in Case 2 during atrial systole seems to have been caused by the

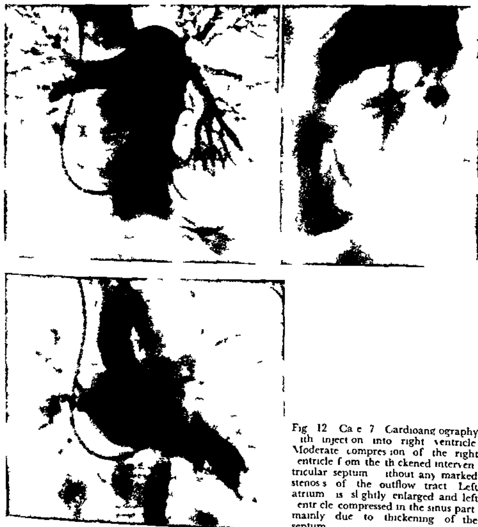


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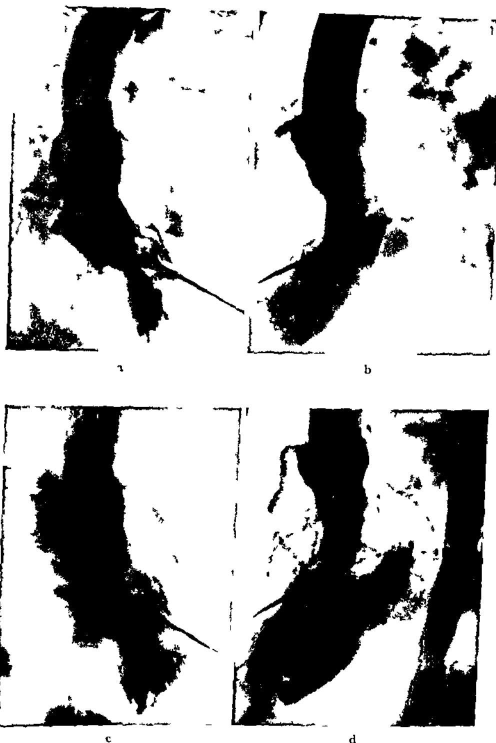


Fig. 13. Case 7. Cardioangiography with injection into the left ventricle. This examination was made 2 years earlier than the cardioangiography with injection into right ventricle as illustrated in fig. 12. The left ventricle is slightly narrowed between the sinus and the outflow tract. The aortic cusps and aorta appear normal. a) and b) systole, c) and d) diastole.



Fig 14 Case 8 Cardioangiography with injection into right ventricle Moderate compression of right ventricle Slight stenosis of the ventricular lumen present between the sinus and the outflow tract After passage of the contrast medium through the pulmonary vessel a considerably enlarged left atrium is evident

stenosis of the ventricular lumen during systole There may consequently be some justification for speaking not only of asymmetric hypertrophy of the myo cardium but also of a disturbance in its mode of contraction Stenosis in the left ventricle is therefore never very obvious in an atonic heart This is il lustrated by Case 2 (Fig 5) in which marked obstruction of the left ventricle could be seen during ventricular systole at cardioangiography and a pressure

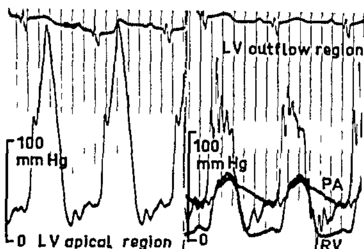


Fig 15 Recordings from Case 7 showing pressure gradient between the apical and the outflow regions of the left ventricle (LV) No pressure gradient between right ventricle (RV) and pulmonary artery (PA) The incisura on the ascending limb of the pressure curve from the apical region of the left ventricle *may indicate that the stenosis in the left ventricle increases during the ejection phase* The end-diastolic pressure of the left ventricle is increased

gradient was recorded during heart catheterization Any stenosis in the left ventricle *could not, however, be detected at operation during induced heart* standstill or at autopsy This abnormal mode of contraction, giving rise to an increasing degree of stenosis of the left ventricle in late systole, was also confirmed by pressure recordings (Fig 15)

Dilatation of the left atrium, which was most clearly seen in Case 1 (Fig 4), may be explained by an increased filling resistance due to diminished distensibility of the left ventricular wall In Case 2 (Fig 5c) the moderate insufficiency of the mitral valve could of course have contributed to the left atrial enlargement The insufficiency may in turn have been produced by the pathologic process in the ventricular wall, which may have displaced the mitral valves, papillary muscles or chordae tendineae in systole so that a leakage ensued

The increasing number of cases which have been reported in the last few years indicates that the condition is not uncommon The differentiation between ordinary valvular or subvalvular aortic stenosis prior to surgery is very important and widens the indication for cardioangiography The differential diagnosis between ordinary valvular and infundibular pulmonary stenosis and low subvalvular stenosis of the right ventricle may also be made by cardioangiography

SUMMARY

Eight cases of low subvalvular aortic stenosis are described. The stenosis is caused by asymmetric hypertrophy and an abnormal course of the muscle bundles of the myocardium of the ventricle causing a disturbance in their mode of contraction. The stenosis is most apparent during late systole. Selective cardioangiography permits the establishment of an accurate diagnosis.

ZUSAMMENFASSUNG

Acht Fälle von tiefer subvalvulärer Aortenstenose werden beschrieben. Die Stenose ist durch asymmetrische hypertrophierte und abnorm verlaufende Muskelbündel des Myokards verursacht, welche die Kontraktion stören. Die Stenose macht sich am Ende der Systole besonders bemerkbar. Selektive Kardio-Angiographie ermöglicht eine genaue Diagnose.

RÉSUMÉ

Les auteurs décrivent huit cas de sténose aortique sous-valvulaire basse. Cette sténose est causée par une hypertrophie asymétrique et un trajet anormal des faisceaux musculaires du myocarde du ventricule, perturbant leur mode de contraction. C'est à la fin de la systole que cette sténose est la plus apparente. L'angiocardiographie sélective permet d'établir un diagnostic précis.

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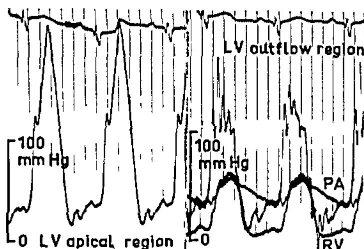


Fig 15 Recordings from Case 7 showing pressure gradient between the apical and the outflow regions of the left ventricle (LV) No pressure gradient between right ventricle (RV) and pulmonary artery (PA) The incisura on the ascending limb of the pressure curve from the apical region of the left ventricle may indicate that the stenosis in the left ventricle increases during the ejection phase The end-diastolic pressure of the left ventricle is increased

dient was recorded during heart catheterization Any stenosis in the left tricle could not, however, be detected at operation during induced heart idstill or at autopsy This abnormal mode of contraction, giving rise to increasing degree of stenosis of the left ventricle in late systole, was also firmed by pressure recordings (Fig 15)

ilatation of the left atrium, which was most clearly seen in Case 1 (Fig 4), be explained by an increased filling resistance due to diminished distensi y of the left ventricular wall In Case 2 (Fig 5c) the moderate insuffi cy of the mitral valve could of course have contributed to the left atrial en ement The insufficiency may in turn have been produced by the patho process in the ventricular wall, which may have displaced the mitral es, papillary muscles or chordae tendineae in systole so that a leakage ed

he increasing number of cases which have been reported in the last few s indicates that the condition is not uncommon The differentiation veen ordinary valvular or subvalvular aortic stenosis prior to surgery is important and widens the indication for cardioangiography The rential diagnosis between ordinary valvular and infundibular pulmonary osis and low subvalvular stenosis of the right ventricle may also be made ardioangiography

SUMMARY

Eight cases of low subvalvular aortic stenosis are described. The stenosis is caused by a symmetric hypertrophy and an abnormal course of the muscle bundles of the myocardium of the ventricle causing a disturbance in their mode of contraction. The stenosis is most apparent during late systole. Selective cardioangiography permits the establishment of an accurate diagnosis.

ZUSAMMENFASSUNG

Acht Falle von tiefer subvalvularer Aortenstenose werden beschrieben. Die Stenose ist durch asymmetrische hypertrophierte und abnorm verlaufende Muskelbundel des Myokardiums verursacht, welche die Kontraktion storen. Die Stenose macht sich am Ende der Systole besonders bemerkbar. Selektive Kardio-Angiographie ermoglicht eine genaue Diagnose.

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Les auteurs decrivent huit cas de sténose aortique sous-valvulaire basse. Cette sténose est causée par une hypertrophie asymétrique et un trajet anormal des faisceaux musculaires du myocarde du ventricule, perturbant leur mode de contraction. C'est à la fin de la systole que cette sténose est la plus apparente. L'angiocardiographie sélective permet d'etablir un diagnostic précis.

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FROM THE DEPARTMENT OF PHARMACOLOGY (DIRECTOR PROF BORJE UVNÄS) KAROLINSKA INSTITUTET AND THE ROENTGEN DEPARTMENT (DIRECTOR PROF ERIK LINDGREN) SERAFIMERLASARETTET STOCKHOLM SWEDEN

EFFECTS OF INTRAVENOUS ADMINISTRATION OF UROGRAPHIC AND CHOLEGRAPHIC CONTRAST MEDIA ON BLOOD PRESSURE AND PERIPHERAL CIRCULATION

An experimental study in cats

by

PERCY LINDGREN and GEORG FREDRIK SALTZMAN

Although intravenous urography and cholegraphy with water soluble iodine contrast media are considered to be relatively harmless procedures various side effects such as vasomotor disturbances e g a fall in blood pressure are frequently reported

LINDGREN et coll in a series of papers on the vascular reactions to contrast media of the tri iodo benzoic acid type described a marked vasodilator effect of one compound sodium acetrizoate (Triurol and Urokon) administered intra arterially for arteriography Of the other compounds sodium diatrizoate (Hypaque and Urografin) and sodium diprotrizoate (Miokon) were found to produce considerably less vascular disturbances (LINDGREN & TORNELL 1958 KAGSTROM LINDGREN & TORNELL 1958 LINDGREN NORDENSTROM & TORNELL 1959) Sodium acetrizoate apart from its use in arteriography and angiocardiography is mainly employed in intravenous urography A fall in blood pressure following the intravenous injection of this compound has been observed both in man and animals (RICHARDSON & ROSE 1950 NAHAS CASTANO ECOIFFIER & ROUANET 1955)

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consisted of directing the blood flow from a cannulated artery or vein via a plastic tube to a drop chamber, from this the blood returned to the animal entering the cannulated distal stump of the same artery or in the case of venous flow the proximal stump of the cut vein The phototube drop counter operated an ordinate recorder The records directly proportional to the drop intervals and indirectly proportional to the rate of flow were calibrated in milliliters per minute Heparin 25 mg/kg was given intravenously in order to prevent clotting

Intravenous injections were made via a thin polythene catheter into a cutaneous vein of the fore leg

Compounds used Adipiodon (iodopamide) (Biligrafin forte 50 % Schering), sodium acetrizoate (Triurol 50 % Leo) and sodium diatrizoate (Hypaque 50 % Winthrop Urografin 60 % Schering)

Results

Adipiodon The common dose for cholegraphy in adult human subjects is 20 ml corresponding to about 0 3 ml kg That dose rapidly injected in cats produced a blood pressure fall amounting to between 15 and 55 mm Hg (15 to 36 %) the average of 8 experiments being 35 mm Hg (26 %) These figures include only the responses obtained with the first injection because the succeeding responses declined so that the third or fourth injection of the same dose produced only a very slight fall in blood pressure Typical responses are seen in Fig 1a Concomitant with the rapid fall of the blood pressure a short lasting decrease of the peripheral blood flow occurred This effect may be considered mainly as passive to the pressure fall baroceptor reflexes may to some extent also be involved

A few cats were pretreated with large doses of an antihistaminic drug in order to determine if the fall in blood pressure after adipiodon might be due to a histamine effect a mode of action that might be suspected from the marked tachyphylaxis Histamine release has now and then been discussed in the literature as a possible explanation of side effects of contrast media However similar results were obtained (Fig 1b)

If the drug was injected slowly (during 5 minutes) the blood pressure showed no significant changes

Although adipiodon is not administered intra arterially in human subjects we investigated this type of administration with due regard to the pharmacologic advantages of studying local vascular effects (localized effects no secondary vasomotor reflexes) Even this contrast medium was found to have a considerable vasodilator effect (Fig 2) although it was less than that of sodium acetrizoate

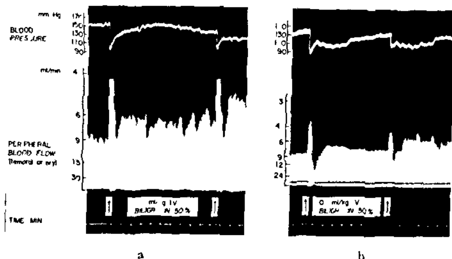


Fig. 1. a) Cat 2.7 kg. Nembutal 40 mg/kg i.p. Blood pressure fall after intravenous adipiodon (Biligrafin 50 %) 0.3 ml/kg. Less effect of second dose. b) Cat 2.1 kg. Nembutal 40 mg/kg i.p. Similar effects as in (a). The cat was pretreated with mepyramine (Anthisan) 10 mg/kg.

A special contrast medium, readily excreted by the liver, is used for cholegraphy. In an extensive study of the blood pressure and heart rate during cholegraphy with adipiodon (iodopamide) (*Biligrafin forte*) SALTZMAN & SUNDSTROM (1960) observed a fall in blood pressure of between 4 and 38 per cent. These authors discussed the clinical implications of their findings but did not enter upon the possible factors lying behind the effects observed.

With the considerable vascular disturbances after the intraarterial administration of the two contrast media sodium acetrizoate and adipiodon in mind, an investigation into the effects of these substances following their intravenous injection by means of the technique used previously was considered to be of interest. The technique permits a study of the blood pressure as well as the peripheral blood flow to be performed. Having regard to the widespread clinical use of sodium diatrizoate, a contrast medium known to have only a slight influence on the vascular system, this compound was also included in the investigation.

Methods. Nineteen cats weighing 1.6 to 3.3 kg, anaesthetized with nembutal (40 mg/kg injected intraperitoneally) or dial (50 to 70 mg/kg i. v.) were used in the experiments.

The arterial blood pressure was recorded from the carotid artery into which a cannula was inserted and connected to an ordinary mercury manometer.

The femoral blood flow was recorded by a technique described by LINDGREN & UVNÄS (1954) and LINDGREN (1958). The paw was tied off in order to obtain an almost pure muscle blood flow. The principle of the method

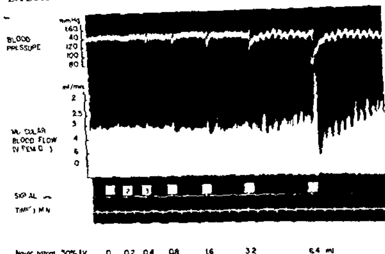


Fig 3 Cat 3 1 kg D al 60 mg kg intravenou ly Effect of ntrav nou injecti ns of sodium acetrizoate (Tr urol 50) (in the various amo ints indicated in the figure) upon blood pressure and periph ral blood flow (Total dosage in mill liter)

a rise of less than 10 mm Hg) Almost no changes in the peripheral blood flow were observed No difference between the two sodium diatrizoate solu tions Hypaque and Urografin was apparent After these preliminary results and with due regard to the previous observations from intra arterial injections that sodium diatrizoate produces but small vascular effects we considered there was little interest in increasing this series of experiments

Discussion

The results of SALTZMAN & SUNDSTROM (1960) on the vasomotor effects of adipiodon were confirmed The present data from cat experiments are, as far as the blood pressure fall on the intravenous administration of adipiodon is concerned even quantitatively quite consistent with those observed by these authors in man The average blood pressure fall was 26 % and 23 % re spectively

Like most contrast media adipiodon was found to have a vasodilator effect provided a concentrated solution was used It seems reasonable to look upon this vasodilator influence as perhaps being due to an unspecific action on the vascular wall producing direct relaxation of the smooth muscle cells Such effects of high concentrated solutions have sometimes been considered as due to the osmotic relationships This may account for some pharmacologic actions of contrast media but it would appear to offer no explanation of their

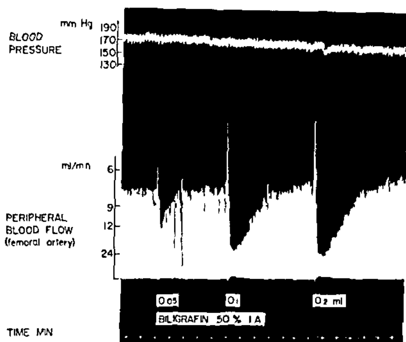


Fig 2 Cat 2 2 kg Nembutal 40 mg/kg i p Vasodilator effects of intra arterial adipiodon (*Biligrafin 50 %*) (Total dosage in milliliter)

Sodium acetrizoate The intravenous injections were made rapidly No or only minor changes in the blood pressure, or the peripheral blood flow appeared in doses up to 0 1 to 0 2 ml/kg A typical experiment is illustrated in Fig 3 When higher doses were given the mean arterial blood pressure fell abruptly after a small initial rise but recovered in one or two minutes For comparison with the effects of adipiodon, 0 3 ml sodium acetrizoate was given as the first dose in 4 cases and it was noted that the fall in blood pressure amounted to 15, 15, 20, 25 mm Hg, respectively Larger doses (1 ml/kg) caused a decrease in blood pressure of about 25 to 35 mm Hg In spite of the marked vasodilator activity the contrast medium had shown when administered intra arterially, intravenous doses produced no increase of peripheral blood flow, unless very high doses were given (No 7 Fig 3) The initial decrease of flow evident is no indication of a vasoconstrictor effect of the drug, but is probably secondary to the considerable but rapidly recovering fall in blood pressure

No tachyphylaxis occurred in experiments in which equal doses of sodium acetrizoate were repeated several times

Sodium diatrizoate The circulatory effects of intravenous sodium diatrizoate (0 3 ml/kg) were insignificant In 14 injections in 4 cats the blood pressure effect varied from a fall of 10 mm Hg to a rise of 20 mm Hg (the average being

ZUSAMMENFASSUNG

Die Administrierung von Adipiodon und Natriumacetrizoat verursachte bei Katzen einen mässigen Blutdrucksfall und hatte gefässerweiternde Eigenschaften, auch wenn der periphere Blutstrom bei intravenöser Injektion der Substanz wenig verändert wurde. Die Erklärung des Blutdrucksfalles wird diskutiert. Wiederholte Adipiodondosen erzeugten abnehmende Reaktionen, nach Natriumacetrizoat fand man jedoch keine Anzeichen einer Tachyphylaxe. Das Natriumdiatrizoat hatte bei intravenöser Injektion keine grösseren Gefässeffekte.

RÉSUMÉ

L'administration d'adipiodone et d'acétrizoate de sodium à des chats entraîne une baisse modérée de la tension artérielle et a des propriétés vasodilatatrices même quand ces substances étant injectées par voie intraveineuse le débit sanguin périphérique est peu modifié. Les auteurs examinent l'explication de cette baisse tensionnelle. La répétition de l'administration d'adipiodone donne des responses moins intenses alors qu'on n'observe pas de signes de tachyphylaxie après l'administration d'acétrizoate de sodium. Le diatrizoate de sodium n'entraîne apparemment pas d'effets vasculaires majeurs quand il est injecté par voie intraveineuse.

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vasodilator influence since intra-arterial injections of a hypertonic NaCl solution (2 to 18 %) do not cause any appreciable vasodilatation (LINDGREN, unpublished data).

Another factor, which may contribute to the explanation of the circulatory changes observed, must however also be discussed. It has recently been reported that contrast media may cause intravascular aggregation of the red blood corpuscles (READ 1959, SOBIN et coll. 1959, BERNSTEIN & EVANS 1960). A sludge of this type following contrast media injected intravenously was shown to cause pulmonary hypertension, which may in turn give rise to diminished cardiac output. This offers a possible explanation for the blood pressure fall observed in the present investigation. The theory is now being investigated and the results will be published separately (LINDGREN, LOFSTRÖM & SALTZMAN).

The difference in the vascular effects caused by sodium acetrizoate and sodium diatrizoate that was known from numerous previous experiments on the peripheral blood flow during arteriography, was further established. As could be expected, sodium acetrizoate, a potent vasodilator, produced a fall in blood pressure on intravenous injection while sodium diatrizoate, a relatively inert vasodilator, gave insignificant effects. Whether or not the phenomenon of erythrocyte aggregation has any bearing upon the difference in the vascular reactions produced by sodium acetrizoate and sodium diatrizoate can hardly be evaluated from the present data.

From a clinical standpoint the experiments with adipiodon show the importance of its injection not being made too rapidly if vasomotor reactions are to be avoided. SALTZMAN (1959) believed that the injection speed was of minor importance in the production of side effects. SALTZMAN & SUNDSTRÖM (1960) considered however that this conclusion did not hold true, and the present results may offer an explanation. In SALTZMAN's previous investigation the patients were given two injections of 20 ml adipiodon 50 % at an interval of 15 minutes, the first injection was given slowly, the second rapidly. No significant difference in the type or frequency of side effects was apparent. It seems probable that the response to the second rapid injection was reduced, for, as shown by the present experiments, the responses to repeated injections of adipiodon considerably declined.

SUMMARY

The administration of adipiodon and sodium acetrizoate in cats caused a moderate fall in blood pressure and had vasodilator properties even if the peripheral blood flow was little affected when the substances were injected intravenously. The explanation of the pressure fall is discussed. Repeated doses of adipiodon produced diminishing responses whereas there was no sign of tachyphylaxis after sodium acetrizoate. Sodium diatrizoate apparently caused no major vascular effects when injected intravenously.

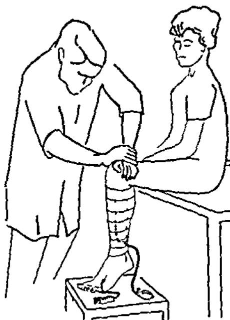


Fig 1 Position of patient The knee loaded for functional test of deep vein

and the time necessary for contrast medium to disappear from them This also holds for the perforator veins which also cannot be judged with any degree of certainty (GREITZ 1955)

Another disadvantage of the method is that it does not enable reliable assessment of the competence of the perforators because when the heavy contrast medium from below rises in the deep veins and reaches the opening of a perforator it will sink down through the perforator like an undercurrent and during this time it is not possible to demonstrate how the blood stream is flowing in the upper part of this vein This technique will not show how the blood normally flows in such a perforator (KJELLBERG 1943 LINDBLOM 1941 MATHIESEN 1958 GREITZ 1955)

A third disadvantage is that the use of muscle contractions to judge the competence of the deep veins is not reliable if the perforators are incompetent for the muscle contractions are performed while the superficial and the deep venous systems are filled with contrast medium If the perforators are incompetent the muscle contractions will squeeze the contrast medium out of the deep veins and through the perforators to the superficial veins a phenomenon for which COCKETT and JONES (1953) coined the term perforant out blow on relaxation of the muscles the deep veins are refilled via the perforators

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LOWER LEG PHLEBOGRAPHY BY AN IMPROVED TECHNIQUE

by

GÖRAN NYLANDER

Clinical venography has found an established place in routine diagnostic roentgenology but so far there is no generally accepted technique of choice.

We use the method described by GULLMO (1956), and although this technique is not ideal it would appear to the writer to be superior to all other procedures available. GULLMO's method is briefly as follows. A tourniquet is wrapped around the leg, held vertically, at a level just above the malleoli. Contrast medium is injected into a vein of the dorsum of the foot and, since all the superficial veins are compressed by the tourniquet, selective filling of the deep venous system is obtained. If perforator veins between the deep and the superficial veins are incompetent, contrast medium will flow through the perforators into the superficial system and varices. A frontal view and a lateral view are sufficient to demonstrate any incompetence of the perforator veins. The patient is then instructed to contract the calf muscles as much as he can a few times, after which frontal and lateral views will show whether the contraction of the muscles has been sufficient to force the contrast medium from the deep veins of the lower leg. This will have occurred if these veins are competent. The same principle is utilized in the method of intraosseous dynamic phlebography described by BAUER & ARNOLDI (1960).

GULLMO's method, however, has certain drawbacks. One of these is that varices, if present, are so rapidly filled with contrast medium that it is difficult to identify, or assess the width of, the deep veins, the competence of the valves

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Fig ? Decompress on techni jue phlebography of lower leg a) and b) Frontal and lateral projecti in with compression of superficial ins Deep veins and val es normal c an l d) Frontal and lateral p ject on ft r decompres ion Insuff c ent perforant ve n (arrows)

on other objective findings The absence of normal valves in the deep veins and varicose changes suggest insufficiency

The technique described above appears time consuming but with some practice the examination of a lower leg requires only about 10 minutes It would appear to the writer that this technique has certain fundamental ad vantages it shows the presence or absence of perforator insufficiency and it enables better examination of the pattern of the deep venous system, and if the perforator veins are competent the functional state of the deep veins

SUMMARY

An improved method of phlebography of the lower leg is described This enables not only more detailed examinat on of the deep venous system but the demonstration of any incom petence of the perforator veins as well

ZUSAMMENFASSUNG

Eine ve besserte Methode der Phlebographie der unteren Extremitat wird b schrieben Diese Methode gestattet nicht nur eine genauere Untersuchung der tiefen Venen sondern auch die Darstellung von Insuffizienz der Perforatorvenen

This perforant back flow thus gives a false impression of deep venous incompetence. Insufficient emptying of the deep veins after muscle contractions should therefore never be interpreted as evidence of insufficiency of the deep veins unless incompetence of the perforators can be excluded with certainty.

Clinicians referring their patients for lower leg venography usually request information as to whether (1) the deep veins are competent, (2) any of the perforant veins are incompetent, (3) to what extent the appearances are dominated by the perforant flow phenomenon and (4) the state of the superficial venous system and whether any varices are present.

Information on the fourth point is usually afforded by the clinical examination. The three other requests are often satisfied only with some difficulty. The following modification of the GULLMO method has certain points in its favour and may afford additional information.

A flat rubber bag of a blood pressure manometer is placed on the lower leg (Fig. 1). The compression bags used for urography may also be employed. The bag should cover all palpable perforant openings in the fascia cruris and any large varices, it is fixed firmly in position with an elastic bandage, care being taken that the latter does not compress the superficial veins. A vein in the dorsal aspect of the foot is punctured, and when the needle has been inserted, the rubber bag is inflated. The elastic bandage round the lower leg then becomes tighter and the superficial veins with the perforant openings are compressed. The rubber bag should not be inflated to such an extent as to compress the deeper veins as well. Practical experience will soon teach the examiner to what extent the bag should be inflated. An injection of 30 ml Urografin 60 % is then made. Good filling will be obtained of the deep veins only, so that the appearances are not masked by superimposed contrast filled superficial veins. One frontal view and one lateral view will then show the width of the deep veins and the presence or absence of valves.

The air is then allowed to escape suddenly from the bag, if the perforant veins are incompetent, the contrast blood in the deep veins will rush through the perforant veins to the superficial venous system. One frontal and one lateral view, taken as soon as possible after release of the compression, will show the width, number and site of any perforators.

The functional state of the deep venous system is then examined. With the knee loaded (Fig. 1) the patient is requested to raise the heel a few times after which a frontal and a lateral view are obtained (Fig. 2). If this muscular activity causes the contrast medium to disappear from the deep veins, they are regarded as competent, if it does not, the deep veins may still be competent provided that perforant veins are incompetent. If the perforators are incompetent, perforant back flow will occur and the contrast medium will persist for a long time in the normal deep veins after muscular contractions. If incompetence of the perforators has been demonstrated, caution must be exercised in the evaluation of the deep venous system and must be founded

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CERVICAL VERTEBRAL PHLEBOGRAPHY

by

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The main features of the anatomy of the veins of the vertebral canal have long been known as a result of dissection studies The first roentgenographic examinations of the epidural veins were carried out in 1952 by FISCHGOLD et coll who injected a water soluble contrast medium into the spinous process of a lower thoracic vertebra and succeeded in demonstrating these vessels in the thoracic and lumbar parts of the vertebral canal SCHOBINGER described the roentgenologic appearances of these veins in more detail HELANDER & LINDBOM in an attempt to demonstrate changes in the epidural veins in connection with disk protrusions in the lumbar vertebral region compressed the inferior vena cava and injected contrast medium into that vein SCHOBINGER endeavoured to outline the epidural veins in the cervical vertebral region by injecting contrast medium into the spinous process of the second cervical vertebra he was only partially successful however and even when the veins were visible they were poorly outlined He summed up his results as follows Since injection of contrast medium into the spinous processes of the cervical vertebrae fails to outline well the internal vertebral venous plexus in the cervical region it presently can be assumed that this method is inadequate for the routine diagnosis of protruded cervical discs

Anatomical investigations have shown that the red marrow in the bodies of the vertebrae contains several venous channels — the basivertebral veins — which unite in the cervical vertebral region into two stems running in an

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RÉSUMÉ

L'auteur décrit une méthode perfectionnée de phlébographie de la jambe. Elle permet non seulement un examen plus détaillé du système veineux profond mais aussi la mise en évidence de toutes les insuffisances des veines perforantes.

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Fig 1 Autopsy material plastic cast anterior posterior and lateral aspects Veins dark vertebral artery medium grey and subarachnoidal space light grey Longitudinal vertebral sinuses (→) Venous plexus dorsal to nerve roots (⇸) Intervertebral veins (⇸) Vertebral veins (↠) Prevertebral veins (→) Postvertebral veins (→) The transverse anastomoses within the cervical region are narrower than those of the thoracic region

Phlebography in vivo After sterilization of the skin one of the cervical vertebral bodies was punctured under local anaesthesia with a needle of the same calibre and type as those used for cerebral angiography The puncture was performed medial to the carotid artery and as close as possible to the midline, with the patient in the supine position During its insertion into the vertebra the needle was slowly rotated and an image intensifier was used to make sure that its tip reached the centre of the vertebral body when it was in that position blood and bone marrow could be aspirated without difficulty In the event of the tip not reaching the correct position the same vertebra could be re punctured provided that the first needle was left in position If the needle was removed leakage of contrast medium into the soft tissues took place from the first puncture In most instances the fifth cervical vertebra was punctured If the pathologic process was believed to be located in the upper cervical vertebral region the puncture was performed in the third cervical vertebra

Saline was injected through the needle without any appreciable resistance being encountered Ten milliliters of Urografin 45 % were then injected as

anterolateral direction and a large dorsally directed main stem that communicates with the epidural veins. It would therefore seem likely that filling of the epidural veins could be achieved by injecting contrast medium into a vertebral body. A technique for vertebral phlebography in the cervical vertebral region has been worked out.

The anatomy of the veins of the cervical part of the vertebral canal was studied in eight cadavers after the injection of contrast medium and plastic material. Vertebral phlebography of the cervical region was carried out in three young subjects without clinical signs of disease in this region. In addition, about 40 patients with clinical signs indicating a protruded cervical disk and two patients with an expanding process in the cervical vertebral region were examined by cervical phlebography after the anatomy had been studied by gas myelography.

Methods

Anatomical investigations. As some of the observations obtained during phlebography in vivo were difficult to explain in the light of the anatomic descriptions available in the literature, it was deemed necessary to make renewed examinations in order to correlate the anatomic and roentgenographic findings. In six cadavers, barium sulphate suspended in gelatine solution was injected into one or several of the cervical vertebral bodies and in a retrograde direction into the vertebral veins. The injections were performed in situ, the vertebral body being punctured percutaneously before the cadaver was opened. After the contrast medium had hardened, the cervical vertebrae were removed in one piece together with the lower part of the clivus, the upper thoracic vertebrae, and the surrounding tissues. The anatomy of the veins was studied by dissection and by roentgenography.

A viscous cold polymerizing plastic mixture was employed in two instances to obtain a cast of the epidural veins and their communications. The cervical vertebrae and adjacent soft tissues together with the lower part of the clivus and the first thoracic vertebra were removed en bloc and plastic catheters were inserted into the vertebral veins and arteries. A plaster cast was made of the specimen and both veins and arteries were flushed out with water. Blue tinted plastic material was then injected into the vertebral veins in a sufficient quantity to fill the venous system; in a similar manner, red tinted plastic was injected into the vertebral arteries. In one of the specimens the subarachnoidal space was filled with a colourless plastic mixture. When the mixture had set, the preparations were immersed in lye and after the surrounding tissues had corroded away, casts of the veins and arteries and, in one preparation, of the subarachnoidal space as well, were obtained. The communications of the veins with one another as well as their relations to the vertebral arteries and the subarachnoidal space could thus be studied.

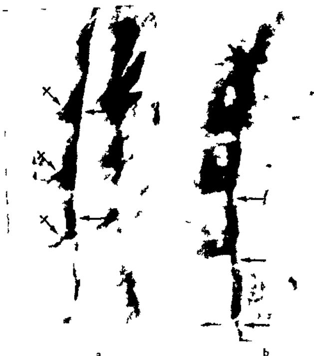


Fig 3 Autopsy material a) Oblique tomography Longitudinal vertebral sinus (→) with infundibular widenings (↔) in intervertebral foramina b) Sagittal tomography Small impressions present at posterior aspect of the longitudinal vertebral sinus at the level of each intervertebral foramen caused by the dural sheaths of the nerve roots (→)

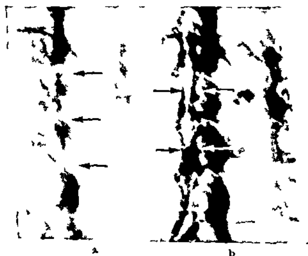


Fig 4 Autopsy material frontal tomography a) The dural sheath of the nerve roots (→) produce impressions in the longitudinal vertebral sinus b Plane through the vertebral artery which surrounded by veins (→)



Fig 2 Autopsy material transverse section (axial tomography) The intervertebral veins (→) surround the nerve root connecting the longitudinal vertebral sinuses (+) with the veins around the vertebral artery (⧺) The dorsal branch of the basivertebral veins (⧻) empties into the segmental anastomoses on the posterior surface of the vertebral body

rapidly as possible and, at the same time, a series of anteroposterior views were taken with a film changer, these were followed, after another injection, by a series of lateral views Oblique projections were also used with the patient turned approximately 10° to 15° to separate the epidural veins of the two sides and, in a few cases, supplemented by a 45° rotation in order to study the veins in the intervertebral foramina

Results

Anatomical investigations Two wide longitudinal, epidural venous channels — the longitudinal vertebral sinuses — lay anteriorly in the vertebral canal and lateral to the posterior longitudinal ligament These channels were thus situated in front of the nerve roots and behind the bodies of the vertebrae and the intervertebral discs (Fig 1) Immediately behind the nerve roots and extending along the vertebral arches an irregular plexus of small epidural veins was evident These veins decreased in size in a dorsal but increased in a caudal direction

The longitudinal vertebral sinuses communicated laterally with a venous plexus around the vertebral arteries through veins which, in the intervertebral foramina, surrounded the dural sheaths of the nerve roots — the intervertebral veins (Fig 2) The sinuses at their origins were widened and infundibular (Fig 3a) The dural sheaths of the nerve roots produced small impressions in the main stems of the epidural veins from behind and from the lateral aspect, and these veins were consequently slightly narrower at the level of the intervertebral foramina than at the level of the vertebral bodies (Figs 3b and 4a) The longitudinal vertebral sinuses were in communication medially with the dorsal main stem of the basivertebral veins through narrow

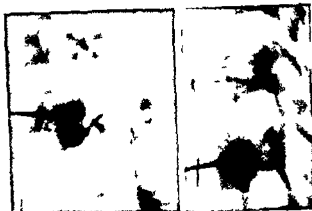


Fig 6 Cervical ertebral phlebography in a healthy subject f ontal and lateral views The bas vertebral ve ns and their connect ons ante i rly and poster orly as well as the venous r te around the vertebral bodies are evident

Phlebography in vivo — normal anatomy The longitudinal vertebral sinuses were usually filled with contrast medium from the second to the seventh cervical vertebra and were projected into each other close to the dorsal surfaces of the vertebral bodies and intervertebral disks in the lateral view (Fig 5a) Their anterior outlines were fairly regular Small shallow impressions were visible posteriorly at the site of emergence of the nerve roots and the sinuses were therefore slightly narrowed at the level of the intervertebral foramina The veins around the vertebral arteries in front of the sinuses were projected into one another and into the vertebral bodies Immediately in front of the ventral surface of the vertebral bodies the prevertebral veins were visible either projected into or in close proximity to each other (Fig 5a) The basivertebral veins were in most instances demonstrated both in the vertebral body injected and in the two contiguous bodies they had a characteristic appearance with their posteriorly directed main stem emptying into the transverse anastomoses between the longitudinal vertebral sinuses (Fig 6) The postvertebral veins were poorly filled or not visible at all By turning the patient 10 to 15 it is possible to distinguish the two longitudinal sinuses as well as the two vertebral venous plexuses from each other

The longitudinal vertebral sinuses had practically the same width on both sides in the frontal view (Fig 5b) The impressions produced by the dural sheaths of the nerve roots were also visible in this projection The vertebral artery appeared as a defect in the surrounding contrast filled venous plexus The prevertebral veins were seen to be united with one another and with the vertebral veins through segmental transverse anastomoses on each side of the midline



Fig 5 Cervical vertebral phlebography in a healthy subject a) Longitudinal vertebral sinuses (→) projected into each other The vertebral veins (⇸) and *the two prevertebral veins are filled with contrast medium (⇻) b) Longitudinal* vertebral sinuses (→) contrast filled The impressions made by the dural sheaths around the nerve roots are evident (⇸) The vertebral arteries are surrounded by vertebral veins (⇻) The prevertebral veins (⇻) are projected on each side of the midline

transverse anastomoses on the posterior surface of the vertebral bodies (cf Fig 2) These anastomoses were considerably narrower in the cervical than in the thoracic and lumbar regions

The veins around the vertebral arteries consisted of one large main stem, the vertebral vein, and a network of smaller veins (Fig 4b)

Two narrow *longitudinal* veins, the prevertebral veins, were *situated on* the anterior aspect of the cervical vertebrae and communicated with the basivertebral veins running anterolaterally as well as with each other and with the vertebral veins through transverse, segmentally arranged anastomoses Thus, together with the intervertebral veins and the transverse bodies, a ring of veins was formed around each vertebral body

A venous plexus, the postvertebral veins, lay in the soft tissues dorsal to the laminae, and this anastomosed with the epidural veins lying behind the nerve roots and *with the* intervertebral veins



Fig 9 a) Gas myelography Large protrusion of the discs between C5—C6 and C6—C7 (→) reaching the anterior aspect of the spinal cord b) Cervical vertebral phlebography Complete compression of the longitudinal vertebral sinuses at the level of C5—C6 (→) with practically no contrast filling below

Fig 10 a) Gas myelography Large protrusion of disk between C3—C4 and C5—C6 (→ not reaching anterior aspect of spinal cord b) Cervical vertebral phlebography Partial compression of longitudinal vertebral sinuses at level of C3—C4 (→) and C4—C5 (→) with complete compression at C5—C6 (↔) The postvertebral vein are richly filled with contrast medium

The postvertebral veins were filled in both total and partial compression (Fig 10) to a larger extent than in the normal cases

Osteophytes at the unco-vertebral joints and intervertebral joints which had been demonstrated by conventional roentgenography deformed the veins around the vertebral artery (Fig 13)

Gas myelography revealed an intramedullary tumor at the level of C1—C3 and an extramedullary intradural tumor at the level of the arch of the atlas in the two cases thought to have an expanding process in the cervical vertebral region At vertebral phlebography in the former case there was no filling of the epidural veins above C3 despite the fact that the injection had been performed as high up as this level (Fig 14) This case at necropsy was found to have a glioma of the upper cervical medulla In the other case the veins around the vertebral arteries were displaced and arched superiorly and anteriorly around the tumor and the postvertebral veins at the level of C2 were displaced in a caudal direction (Fig 15) This case was one of generalized neurofibromatosis and at operation a neurinoma was removed





a



b

Fig 7 Cervical vertebral phlebography in a healthy subject oblique position Infundibular widenings of the longitudinal vertebral sinus

Fig 8 Gas myelography Medium sized protrusions of the discs between C4—C5 and C5—C6 not reaching the interior aspect of the spinal cord b) Cervical vertebral phlebography The longitudinal vertebral sinuses are compressed at the level of C4—C5 and C5—C6 (→) Incomplete filling below C4—C5 Filling of postvertebral veins

The outline of the longitudinal vertebral sinuses was jagged anterolaterally in the 45° oblique projection owing to the infundibular widenings at the intervertebral foramina (Fig 7)

Phlebography in vivo — pathologic changes The disk protrusions observed with gas myelography bulged from the front into the longitudinal vertebral sinuses at the level of the intervertebral disks Small protrusions produced partial occlusion of the sinuses, which were incompletely filled below that level (Fig 8) and larger protrusions caused complete compression (Figs 9 and 10) The vertebral sinuses seemed in some cases to be widened above a compressed area (Fig 11) By turning the patient 10° to 15° it was possible to determine whether one or both of the vertebral sinuses were involved (Fig 12)



Fig 13 a) Osteophytes around the intervertebral and unco-vertebral joints of C5—C6 project into the right intervertebral foramen (→) b) Cervical vertebral phlebography The vertebral veins on the right side are deformed by osteophytes (→)

Fig 14 a) Gas myelography Intramedullary tumor reaching from C1 to C3 b) Cervical vertebral phlebography Although contrast medium was injected into body of third cervical vertebra the epidural veins are not filled behind or above this bone

would therefore seem to be especially suitable for the diagnosis of disk protrusion

Pathologic findings were obtained at cervical phlebography in all our cases in which protrusion of a disk was demonstrated by gas myelography Even small changes could be verified by vertebral phlebography In a few cases compression of the epidural veins at the level of the intervertebral disks could be demonstrated although no deformity of the subarachnoidal space was present at gas myelography (Fig 16) Furthermore cervical phlebography is probably superior to gas myelography for determining the side on which a protruded disk is located It is not possible with gas myelography to diagnose an intraforaminal rupture of a disk which probably is the case with cervical phlebography For this purpose however, phlebography should be performed with simultaneous serial tomography Continued investigations into the possibilities offered by such a technique are being planned Vertebral phlebography as compared to gas myelography presents however one obvious drawback in the diagnosis of a disk protrusion When the latter is so large that it completely compresses the epidural veins protrusions caudal to the compressed segment can only be studied after contrast medium has been injected into a vertebral body below that level Myelography with oily contrast media is well suited to demonstrate disk protrusions The method however has certain disadvantages The contrast medium has to be removed and this makes the procedure time-consuming and unpleasant for the patient It should also be remembered that arachnitis arising after oil myelography may produce clinical complications



Fig 11 a) Gas myelography Large disk protrusion between C5—C6 (→) not reaching the anterior aspect of the spinal cord b) Cervical vertebral phlebography The longitudinal vertebral sinuses at the level of C5—C6 (→) with no contrast filling below Above the compression the sinuses are widened

Fig 12 Cervical vertebral phlebography a) True lateral view showing compression of longitudinal vertebral sinuses at level of C5—C6 (→) b) In the oblique position it is demonstrated that the two sinuses are separated Only the left is compressed (→) and dilated above the right vein is not affected (↔)

Discussion

No method has been available for routine contrast examination of the epidural veins in the cervical vertebral region and only occasional and fragmentary filling of these veins has been obtained with earlier methods Injection into a spinous process has resulted mainly in filling of the postvertebral veins By *injecting the contrast medium into the body of a vertebra*, on the other hand, it is possible to fill the veins in the epidural space as well as the veins around the vertebral artery and the basivertebral veins in one or several vertebral bodies The method ought therefore to be useful for the examination of pathologic processes that deform the epidural space, the soft tissues adjoining the vertebral artery, and the marrow cavities of the vertebral bodies It should supply information regarding the circulation in the contrast filled veins

The examination is easy to perform It involves no particular ordeal for the patient, and no complications have arisen

Protruded disks that deform the subarachnoidal space always involve the the epidural space but some protrusions affect only the latter The method

well as more or less complete filling of the postvertebral veins were evident Further investigations may perhaps show whether there is any connection between these disturbances in the venous circulation and myelopathy caused by disk protrusion

SUMMARY

A new technique for vertebral phlebography of the cervical region is described Protrusion of intervertebral disks and tumors in the vertebral canal affect the epidural veins and compression or displacement of the vertebral arteries may be demonstrated Circulatory disturbances in the veins under examination seem to be present in connection with disk protrusion and may be of significance in the development of myelopathy

ZUSAMMENFASSUNG

Eine neue Technik fur vertebrale Phlebographie der Cervikalregion wird beschrieben Intervertebrale Diskusprotrusion und Tumoren im Vertebralkanal beeintrachtigen die epiduralen Venen Kompression oder Dislokation der vertebralen Arterien können dargestellt werden Zirkulationsstorungen der Venen scheinen bei Fallen von Diskusprotrusion vorhanden zu sein und durften fur die Entwicklung von Myelopathien von Bedeutung sein

RÉSUMÉ

Les auteurs decrivent une nouvelle technique de phlébographie vertébrale de la région cervicale La protrusion des disques intervertébraux et les tumeurs du canal rachidien peuvent atteindre les veines épidurales et on peut mettre en évidence une compression ou un déplacement des arteres vertébrales Les troubles circulatoires des veines examinées semblent en relation avec les protrusions discales et peuvent avoir un rôle dans l apparition de myélopathies

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Fig 15a Fig 15b

Fig 15 a) Gas myelography Juxta medullary tumor at the level of the axis (→) b) Cervical vertebral phlebography The vertebral veins are compressed and displaced *in an arch anteriorly* and superiorly (→) The postvertebral veins at the level of C2 are displaced caudally (+)

Fig 16 a) Gas myelography Disk protrusions between C5—C6 and C6—C7 (→) but none above these levels b) Cervical vertebral phlebography Compressions of longitudinal vertebral sinuses at the level of all intervertebral disks below C2—C3



Fig 16a Fig 16b

Changes in the veins around the vertebral arteries were demonstrated in cases in which osteophytes bulged into the intervertebral foramina. Vertebral phlebography may thus afford information regarding compression or displacement of the vertebral artery.

Intraspinal neurinomas can be diagnosed by vertebral phlebography since they lie close to the intervertebral foramina and influence the epidural veins and *their communications in those areas. We have had no experience* with vertebral phlebography in meningeomas but in all probability ventrolateral meningeomas affect the epidural veins in the same way as neurinomas. Dorsolateral meningeomas may also possibly change the epidural veins in the anterior part of the vertebral canal by displacing the spinal cord. Intramedullary tumors may compress the epidural veins as was shown in one of our cases.

As the pressure in the efferent veins is much higher than in the surrounding veins, vertebral phlebography is not suitable for the examination of an arteriovenous aneurysm in *the vertebral canal, it is unlikely that contrast medium* injected into a vertebral body will pass over into the efferent veins from an arterio*venous aneurysm*.

Circulatory disturbance in the veins of the vertebral canal was observed both in cases of tumor and disk protrusion. In several cases of a protruded disk, widening of the longitudinal vertebral sinuses above the protrusion as

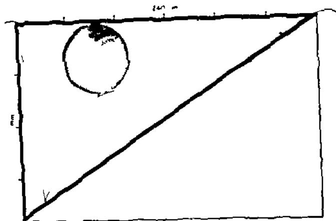


Fig 1 Diagrammatic representation of the phantom Spheres of mix D are slightly lighter than water and by an arrangement of fine threads can readily be placed in the desired position

BERNE & JONSSON (1959) and MACINTYRE et coll (1959) have suggested taping of all primary impulses on a magnetic tape recorder and play back of a series of scintigrams with different counting rate cut off levels

The following investigation was planned to find out what improvement could be obtained by the use of an instrument (Memonucleograph — BERNE & JONSSON) which makes it possible to produce a series of scintigrams with contrast amplification and varying counting rate cut off levels The studies were carried out in phantoms

Measuring technique The LKB scintigraph (JONSSON et coll 1957) which has an electromechanical printer was used at a scaling factor (counts/print) of 4 and a speed of 21 0 cm per minute The distance between parallel lines was 0 6 cm and the recording was made to a scale of 1 1 For the collimating system a cylindric collimator with a caliber of 12 mm and a length of 85 mm was employed The scintillation crystal made of thallium activated sodium iodide had a diameter of 1 5 inches (about 38 mm) and a thickness of 1 0 inch (about 25 mm) It was shielded in all directions except for the collimator opening by at least 5 cm lead A single channel pulse height analyzer was connected the channel being adjusted to the 411 keV peak of Au^{198} The window opening was 25 per cent The collimator was 3 5 cm distant from the phantom surface

Impulses from the detector were simultaneously fed to the recording device of the scintigraph and the magnetic tape recorder Recordings were made at a tape speed of 95 mm per second and played back at a speed of 1 520 mm per second As a rule six photographs were taken at different suppressor settings of each recording The first photograph was taken without suppression

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DETECTION OF SPACE OCCUPYING LESIONS IN THE LIVER

by

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Since the introduction by STIRRET et coll. (1954) of the method of detecting space occupying lesions in the liver by colloidal radioactive gold, Au^{198}, several reports on its clinical serviceability have been published (ANDREWS et coll. 1956, VON RENFER et coll. 1957, FRIEDELL et coll. 1957, HELANDER et coll. 1958, DONATO et coll. 1959, DOEHNER et coll. 1960, WAGNER et coll. 1960). Other materials, which have been used for the same purpose, are I^{131} labelled Rose Bengal (FRIEDELL et coll. 1957, BENDER & BLAU 1959, DOEHNER et coll. 1960, WAGNER et coll. 1960), RIHSA (FRIEDELL et coll. 1957, BONTE et coll. 1960), and tetraiodophenolphthalein (FRIEDELL et coll. 1957). Compounds of positron emitting isotopes (ARONOW et coll. 1959) have also been recommended. Each of these materials is deposited in functioning liver tissue, or in the reticuloendothelial cells of the liver, and hepatic tumours are defined with the aid of an automatic scanner as zones of radioisotope deficit. Since small tumours are often enveloped by functioning liver tissue the scanning device has to record relatively small changes in counting rate, and the data must be presented in a readily interpretable form. To this end various methods of background suppression and contrast amplification have been elaborated (FRIEDELL et coll. 1957, MACINTYRE et coll. 1958, BENDER & BLAU 1959, et alii). With background suppression by the counting rate cut off method the tumours will be detected only when the cut off level is set between the right points

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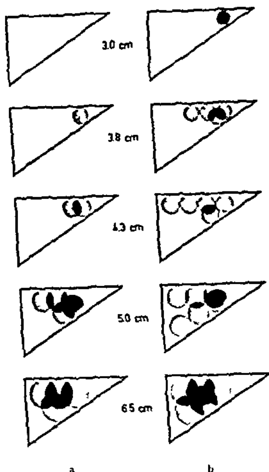


Fig. Each circle denotes the position of a sphere clearly identifiable at one scintigraphic test. a) Scintigraphy without background suppression. b) Scintigraphy with counting rate cut-off at varying levels.

Spheres 5.0 and 6.5 cm in diameter were identifiable anywhere in the phantom.

In scintigraphic studies without background suppression the possibility of identifying the spheres was considerably less (Fig. 2).

In the autoradiographic study the region with no appreciable darkening of the film was equal in size to the grossly and microscopically infiltrated area and no zones with a lower concentration of Au* were detectable around the metastases (Fig. 3).

and the subsequent photographs with progressively increasing suppression, so that isoactivity curves of the examined region were obtained.

Phantom. The phantom, made of 5 mm perspex (Fig. 1), was triangular in cross section and had a rectangular surface area of 240 mm by 240 mm and a maximum depth of 150 mm. It was filled with water, to which 0.5 mC Au^{198} was added. Spheres of various sizes were prepared from mix D (JONES 1949) for use as inactive volumes which, by an arrangement of fine threads, could be placed in the desired position. These spheres were moved in the central axis across the top or across the bottom of the phantom. Fifty scintigrams were taken with space occupying spheres of different sizes and in various positions. Each scintigram was independently evaluated by three observers. Only scintigrams with clearly identifiable zones of lower activity were considered significant.

Autoradiography. In order to ascertain whether the results of phantom tests might be applicable to patients with space occupying lesions of the liver, autoradiographic studies were carried out in a case with multiple liver metastases from a carcinoma of the colon. The aim was to find out whether the metastases were surrounded by zones with a lower concentration of the radioisotope. For this purpose 8 mC colloidal Au^{198} with an average particle size of 50 to 60 Å was administered to the patient shortly before death. Necropsy was performed within 12 hours after death. Autoradiograms were taken from deep frozen sections (— 80° C) 20 μ thick with the use of the method reported by ULLBERG (1958). The same frozen sections were subsequently stained and examined histologically for estimation of the size of the metastases.

Results

By preparing a series of scintigrams at various background suppression levels it was possible to identify smaller spheres than those identifiable under otherwise identical conditions by scintigraphy without a Memonucleograph. In the above mentioned triangular phantom, scintigraphy with contrast amplification and varying counting rate cut off levels yielded the following results (Fig. 2b).

A sphere 3 cm in diameter was identifiable in parts of the phantom up to 4.5 cm in depth, but not in the part with a depth of 6 cm. A sphere 3.8 cm in diameter could be clearly identified in the 6 cm deep part when placed close to the bottom, and also in the 9.5 cm deep part when placed close to the surface. It could not be identified in the 11 cm deep part.

A sphere 4.3 cm in diameter was identifiable at any point close to the surface. It could be identified in the 7.5 cm deep part of the phantom, but not in the 9 cm deep part when close to the bottom.

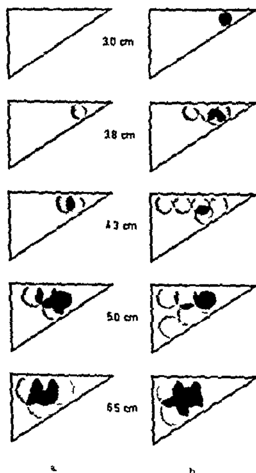


Fig 2. Each circle denotes the position of a sphere clearly identifiable in one scintigraphic test. a) Scintigraphy without background suppression. b) Scintigraphy with counting rate cut-off at varying level.

Spheres 5.0 and 6.5 cm in diameter were identifiable anywhere in the phantom.

In scintigraphic studies *without* background suppression the possibility of identifying the spheres was considerably *less* (Fig 2).

In the autoradiographic study the region with no appreciable darkening of the film was *equal in size* to the grossly and microscopically infiltrated area and no zones with a lower *concentration* of Au^{198} were detectable around the metastases (Fig 3).

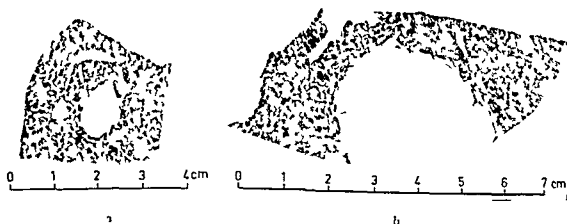


Fig. 3. Autoradiograms of preparation from a liver with multiple metastases of colonic carcinoma. The patient had received colloidal Au^{198} with an average particle size of 50 Å. The inactive zones correspond exactly to the size of the metastases. The metastasis shown in (a) is surrounded by functioning liver tissue; that in (b) is at the liver surface.

Discussion

Despite the use of an improved method, only fairly large spheres could be clearly identified in deep parts of the phantom. The results could be improved by the use of focussing collimators and probably by colour scintigraphy (Mallard & Peachey 1959) combined with playback from magnetic tape, as well as by rotational scanning (Kuhl 1958) and the use of other isotopes. The investigation shows, nevertheless, that the method involving recording of all primary data and reproduction of several scintigrams with contrast amplification and increasing background suppression is a definite improvement of the liver scanning technique — an improvement which merits further development.

Modifications of the scintigraphic technique should be tested primarily on suitable phantoms which facilitate comparative evaluation of the results obtained with different methods. The phantom employed in this investigation, though not a realistic model of the liver, is extremely simple. The conditions obtained in the phantom, moreover, can be readily reproduced and described.

In evaluating the results of phantom studies, only scintigrams with clearly identifiable zones of lower activity are classed as positive. The same should be the case in clinical practice, where false positives must be avoided if the method is to be of practical value. In view of geometric factors, body background, respiratory interference, and the irregularities normally present in the liver, in vivo determinations will be less accurate than those on models. If metastatic lesions in the liver were surrounded by zones with a decreased concentration of the radioisotope, the results of in vivo measurements would be enhanced. No such zones are to be expected, however — at least not when colloidal materials are used for the tests (Fig. 3).

Acknowledgements

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SUMMARY

A method is investigated which after only one recording session permits the preparation of a series of scintigrams with contrast amplification and varying counting rate cut-off levels Tests were performed using a triangular phantom filled with a solution containing the radioactive isotope Au^{198} in which spherical objects made from mix D were placed in various positions The method was found to enable a definite improvement in the liver scanning technique

ZUSAMMENFASSUNG

Eine Methode wird studiert welche die Darstellung einer Serie von Scintigrammen mit erhöhertem Kontrast und variierter Hintergrund Unterdrückung erlaubt Die Methode wurde experimentell geprüft mit der Hilfe eines triangularen Phantomes das mit einer Lösung von radioaktiven Isotope Au^{198} gefüllt wurde und in dem sphärischen Objekte aus »mix D« an verschiedenen Stellen angebracht wurden Eine definitive Verbesserung der Leberscintigraphie kann durch dieser Methode erreicht werden

RÉSUMÉ

Les auteurs analysent une méthode qui permet après une seule séance d enregistrement de préparer une série de scintigrammes avec amplification de contraste et variation du niveau de discrimination de hauteur d impulsions Ils l ont expérimentée sur un fantome triangulaire rempli d une solution contenant l isotope radioactif Au^{198} dans lequel étaient placés dans diverses situations des objets sphériques en «mix D» Ils ont constaté que cette méthode apporte une nette amélioration à la technique de scintigraphie hépatique

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FROM THE NEUROLOGIC CLINIC (ACTING DIRECTOR DOCENT EERO HILLBOM)
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ANEURYSMAL BONE CYST OF THE FOURTH THORACIC VERTEBRA WITH COMPRESSION OF THE SPINAL CORD

Report of a case

by

MAURI ROUKKULA and EINAR SALOVAARA

The concept of aneurysmal bone cyst was introduced by JAFFE and LICHTENSTEIN in 1942 who reported 2 cases The second thoracic vertebra in a young man of 18 was involved in one of these cases

It has since become apparent that an aneurysmal bone cyst is a distinct clinical and pathologic entity although there has been reluctance on the part of some authors to separate it from hemangiomas in general (e g HADDERS et coll) However CRUZ et coll advanced certain points in the differential diagnosis of giant cell tumours and hemangiomas In aneurysmal bone cyst giant cells do not form a homogeneous pattern with regularly interspersed cells and although multinucleated they seldom attain as large a size as in true giant cell tumours The latter lacks the characteristic blood filled vascular spaces These are tortuous large and separated by fibrous stroma which contains no muscular layers thus differentiating this lesion from true blood vessel tumors of bone

Aneurysmal bone cyst is a benign osseous lesion (1) of unknown etiology (2) and is encountered most commonly in the long bones and the spine (8) The neural arch is the site of predilection of aneurysmal bone cyst of the spine (9) whereas hemangiomas and metastases usually arise in the body of the vertebra (3 10)

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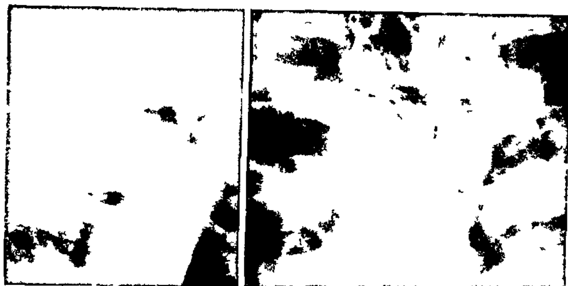


Fig 1 Cystic changes in the fourth thoracic vertebra at roentgen examination No vertical striation

The roentgen appearances of an aneurysmal bone cyst are characterized by a cystically transformed and expanding destructive lesion with a thin shell of periosteal new bone (8) The lesion may be difficult to demonstrate in roentgenograms of the spine (1), however, and the appearances may suggest a primary tumour or metastases According to DAHLIN et coll , vertebral hemangiomas, unlike aneurysmal bone cysts, do not erode contiguous structures and the vertical striations typical of hemangiomas of the spine are not seen in the latter

It is nevertheless possible even in indefinite cases to arrive at a correct diagnosis from a biopsy specimen However, as an aneurysmal bone cyst forms a blood filled expanded sponge, profuse bleeding may cause serious interference with the biopsy The importance of the procedure lies in the elimination of sarcomas (2)

Curettage and roentgen therapy have been employed in the management of aneurysmal bone cysts, and since the lesion is benign the therapeutic results have been good (3) However, compression of the spinal cord and the resulting complications from an aneurysmal bone cyst situated in a vertebra constitute a serious risk LICHTENSTEIN emphasized the speedy instigation of roentgen therapy in these cases

Case report

Female aged 53 with a blood pressure of about 200 mm Hg for about a year developed acute paresis of both lower limbs without any other signs while doing housework she was confined to bed unable to move the right lower leg but able to move the left The lower limbs were spastic and the tendon reflexes markedly increased Babinski + 1 a Rossolimo + 1 a ankle clonus + 1 a No changes present in the upper limbs Hypo esthesia and hypo algesia were established up to the level of the fifth thoracic dermatome the sense of vibration



Fig Photomicrograms (l ft × 40 and right × 200) show ng structures tvp cal of aneurysmal bone cyst.

was also reduced up to the same level There was marked tenderness on palpation near the fourth thoracic vertebra (fifth thoracic dermatome) The cerebral nerves were intact On lumbar puncture Queckenstedt s sign negative CSF pressure 175 mm H O Examination of the spinal flu d showed Nonne + Pandy − proteins 1C0 mg glucose 65 mg % 9 small lymphocytes mm³ mastix 222211 sitolipin

On roentgen examination the bone structure of the fourth thoracic vertebra was found to be largely cystic *particularly in the lamina* pedicles the right transverse process and body of the vertebra esp cially posteriorly For this reason the right pedicle was not visible and the left pedicle only faintly *outlined in tl e frontal* view The laminae on both sides protruded eccentrically with an arched *contour and* a thin obviously periosteal new bone shell was irregularly distributed over the surface of the protrusion No vertical striations were present (Fig 1) No other spinal *changes apart* from spondylosis in the lumbar region

At operation (decompression laminectomy Dr af BJORKESTEN) a bone tumour was found in the arch of the fourth *thoracic vertebra* The ar h was thickened and bled profusely The tumour caused comp ession from the right into the dural sac posteriorly The dura was not op ned but as much as pos*s*ible *of the tumour* was removed and the dural sac regained its normal shape

H tologi examination (Dr Ritama) of the operat on specimen revealed an aneurysmal bon cyst (Fig) The sample contained *angiomatoid* tumour material consisting of numerous blood-contain g cav ties with walls of sl ghtly mucinous loose tissue the cells of which resembled fibroblasts A f w cells of this type *lined the ca* ities but there were no muscle fibres n th walls The cavities were separated by similar loose connective tissue with numerous d licat new l formed bony trabeculae and isolated *osteoclasts* in some areas the latter were present ith trab culations



Fig. 1. Cystic changes in the fourth thoracic vertebra at roentgen examination. No vertical striation.

The roentgen appearances of an aneurysmal bone cyst are characterized by a cystically transformed and expanding destructive lesion with a thin shell of periosteal new bone (8). *The lesion may be difficult to demonstrate in* roentgenograms of the spine (1), however, and the appearances may suggest a primary tumour or metastases. According to DAHLIN et coll., vertebral hemangiomas, unlike aneurysmal bone cysts, do not erode contiguous structures and the vertical striations typical of hemangiomas of the spine are not seen in the latter.

It is nevertheless possible even in indefinite cases to arrive at a correct diagnosis from a biopsy specimen. However, as an aneurysmal bone cyst forms a blood filled expanded sponge, profuse bleeding may cause serious interference with the biopsy. *The importance of the procedure lies in the elimination of sarcomas* (2).

Curettage and roentgen therapy have been employed in the management of aneurysmal bone cysts, and since the lesion is benign the therapeutic results have been good (3). However, compression of the spinal cord and the resulting complications from an aneurysmal bone cyst situated in a vertebra constitute a serious risk. LICHTENSTEIN emphasized the speedy instigation of roentgen therapy in these cases.

Case report

Female, aged 53, with a blood pressure of about 200 mm Hg for about a year, developed acute paresis of both lower limbs without any other signs while doing housework. She was confined to bed, unable to move the right lower leg but able to move the left. The lower limbs were spastic and the tendon reflexes markedly increased. Babinski + 1 a, Rossolimo + 1 a, ankle clonus + 1. No changes present in the upper limbs. Hypo esthesia and hypo algesia were established up to the level of the fifth thoracic dermatome, the sense of vibration

AUS DER MEDIZINISCHEN UNIVERSITÄTSKLINIK (DIREKTOR PROF L HEILMEYER)
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BEZIEHUNGEN ZWISCHEN HERZVOLUMEN KÖRPERGEWICHT, KÖRPERLICHER LEISTUNGS-FÄHIGKEIT UND BLUTVOLUMEN BEI GESUNDEN MÄNNERN UND FRAUEN UNTERSCHIEDLICHER LEISTUNGSBREITE

von

K MUSSHOFF H E A SCHMIDT H REINDELL K KÖNIG D BILGER
BURCHARD E HELD und J KEUL

Die röntgenologische Beurteilung der Herzgröße sollte da keines der ein und zweidimensionalen Röntgenmaße für die Gesamtgröße des Herzens repräsentativ ist, im volumetrischen Maß erfolgen (ROHRER 1916 HAMMER 1928 KAHLSTORF 1932 LUDWIG 1939 LILJESTRAND LYSHOLM NYLIN & ZACHRISSON 1939 JONSELL 1939 BJÖRCK 1944 und 1949 LARSSON & KJELLBERG 1948 ZDANSKY 1949 FUCHS & BAYER 1953 KJELLBERG 1953 MUSSHOFF und Mitarb 1954 1956 1958 1959 GEBHARDT 1957 AMUNDSEN 1959 BRAUN 1960 BUCHNER & GRIESE 1960) Das gemessene absolute Volumen ist aber keinesfalls ein Maß für die Normgröße des Herzens Die Entscheidung der Frage ob eine gegebene Herzgrösse normal oder nicht normal ist ist allein durch den Vergleich des absoluten Herzvolumens mit anderen Körper und Kreislaufgrossen das heisst durch die korrelative Herzgrössenbeurteilung möglich Als Vergleichsgrossen des Herzens werden anatomische Maße (Körpergewicht Körperoberfläche und Blutvolumen beziehungsweise die gesamte

Diese Arbeit ist Herrn Professor Dr Hans v Braunbehrens zum 60 Geburtstag gewidmet Auszugsweise auf dem 9 Intern Congr für Radiologie in München 1959 vorgetragen Bei der Redaktion am 4 Juli 1961 eingegangen

The patient made a good recovery from the operation and was given roentgen therapy. Follow up examination 6 months later established that her *condition had improved*. She was then able to move her right lower limb a little and there were no sensory disturbances. The lower limbs were still spastic, however, and the patient was unable to walk.

As in this case the roentgenographic appearance seemed to indicate hemangioma, although the vertical striations typical of this condition were absent and the histologic appearances differed from typical hemangioma and giant cell tumour, and as the radiographic differences in appearance may often be small, it may *be well to keep in mind the view advanced by* LICHTENSTEIN that a roentgenologically diagnosed but histologically unverified vertebral hemangioma may in fact be an aneurysmal bone cyst.

SUMMARY

A case of an aneurysmal bone cyst of the fourth thoracic vertebra with compression of the spinal cord is described and the differential diagnosis discussed.

ZUSAMMENFASSUNG

Ein Fall einer aneurysmatischen Knochenzyste des vierten Brustwirbels mit Kompression des Rückenmarks wird beschrieben und die Differenzialdiagnose besprochen.

RÉSUMÉ

Présentation d'un cas de kyste osseux anévrismal de la quatrième vertèbre dorsale avec compression de la moelle épinière, discussion du diagnostic différentiel.

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Bei diesen Untersuchungen von KJELLBERG und Mitarb (1949, a und b) wurde die Leistung nach einem Leistungstest von WAHLUND (1948) bestimmt welcher die Arbeit an einem Fahrradergometer wahrend einer Pulsfrequenz von annahernd 170 Herzschlagen pro Minute 6 Minuten lang mißt und die Haemoglobinmange *mittels der alveolaren Kohlenmonoxydmethode* nach SJOSTRAND (1948) bestimmt In diesen Untersuchungen wurde eine sehr enge lineare Beziehung zwischen den drei Grossen Herzvolumen Blutvolumen bzw Gesamthaemoglobin und korperlicher Leistung sowohl bei Kindern Frauen und Mannern als auch bei Sportlern festgestellt

Aufgabe der folgenden Untersuchungen war es die Beziehungen zwischen dem Herzvolumen einerseits und dem Korpergewicht dem Blutvolumen und der korperlichen Leistungsfähigkeit andererseits sowie die Beziehungen der vier Grossen untereinander an einem gleichen aus Frauen und Mannern unterschiedlicher Leistungsbreite bestehenden Kollektiv

Untersuchungsgut Das Untersuchungsgut besteht aus 36 Mannern im Alter von 18—19 Jahren 39 Mannern im Alter von 20—40 Jahren 25 Frauen und 44 mannlichen Hochleistungssportlern

Methode

1 Das *Herzvolumen* (HV) wurde nach der Formel von ROHRER (1916/17) und KAHLSTORF modifiziert nach MUSSHOFF & REINDELL (1956) berechnet Die Formel lautet bei Benutzung von 2 m — Fernaufnahmen Vol = 0 4 × l b × t_m wobei l der Lange und b der Breite des MORITZ schen *Herzvierecks der Frontalprojektion (1905) und* t_{max} *dem grossten* horizontalen Riefendurchmesser der Sagittalprojektion nach ROHRER entspricht Die Bestimmungen erfolgten in horizontaler Ruckenlage (MUSSHOFF u Mitarb 1954 1956 1957 1958)

2 Als Maß der korperlichen *Leistungsfahigkeit* diente die maximale im steady state erreichbare Sauerstoffaufnahme pro Minute (O_2 Aufn max) und als Maß der Leistung und Oekonomie die maximale im steady state erreichbare Sauerstoffaufnahme pro Pulsschlag der maximale Pulssauerstoff (O Puls max) (REINDELL KIRCHHOFF MUSSHOFF KLEPZIG 1956 MUSSHOFF REINDELL STEIM KONIG 1959

3 Die Bestimmung des *Blutvolumens* (Bl V) erfolgte nach der Methode von GRAY & STERLING (1950 Zur Methode siehe SCHMIDT & HOFFMANN (1959 1960)

4 Das *Gesamthaemoglobin* (*Ges Hb*) wurde durch Multiplikation des Blutvolumens mit dem prozentualen Haemoglobingehalt (in g) errechnet

5 An *statistischen Werten* wurden angewendet Mittelwert (M) Streuung bzw Standart deviation (Sigma der Korrelationskoeffizient r und der mittlere Fehler des Korrelationskoeffizienten (ε r) t Werte der Student schen Verteilung und die Zufallswahrscheinlichkeit (P) Eine Zufallswahrscheinlichkeit von P zwischen 0 05 und 0 01 wurde als wahrscheinlich signifikant (*) von P zwischen 0 01 und 0 001 als signifikant (**) und von P kleiner als 0 001 als hoch signifikant (***) bezeichnet

Hämoglobinmenge) und funktionelle Maße des Körpers (körperliche Leistungsfähigkeit, Schlagvolumen, arterio-venöse Differenz und Minutenvolumen) verwendet.

Die Beziehung des Herzvolumens mit dem Körpergewicht wurde erstmalig von KAHLSTORF untersucht. *Er stellte zwischen beiden Grössen eine lineare* Korrelation fest, wobei Männer ein grösseres relatives Herzgewicht als Frauen haben. Diese Feststellung wurde in der Folgezeit mehrfach bestätigt (COMEAU & WHITE 1939, LUDWIG 1939, LILJESTRAND und Mitarb. 1939, BIÖRCK 1944, KJELLBERG, RUDHE & SJÖSTRAND 1949, LIND 1950, MAUREA et coll. 1955, MUSSHOFF und Mitarb. 1956, 1957, 1958).

Die zuerst von LYSHOLM, NYLIN & QUARNA (1934) untersuchte Beziehung des Herzvolumens zur Körperoberfläche entspricht hinsichtlich des Grades der gegenseitigen Abhängigkeit der Beziehung des Herzvolumens zum Körpergewicht (LUDWIG, LILJESTRAND und Mitarb., BIÖRCK, KJELLBERG und Mitarb., LIND, MAUREA und Mitarb., MUSSHOFF und Mitarb.). Da die Abhängigkeit des Herzvolumens von der Körperoberfläche aber keine lineare, sondern eine quadratische Funktion ist und der Quotient Herzvolumen/Körperoberfläche *mit zunehmendem Herzvolumen somit grösser wird* (MUSSHOFF, REINDELL, KÖNIG und Mitarb. 1961, KÖNIG, REINDELL, MUSSHOFF und Mitarb. 1961), *geben wir selbst in Übereinstimmung mit* BIÖRCK dem Korrelat Herzvolumen : Körpergewicht den Vorzug vor dem Korrelat Herzvolumen : Körperoberfläche.

Von NYLIN (1933) und LYSHOLM und Mitarb. (1934) wurde erstmalig mit dem Ruhe-Schlagvolumen ein funktionelles Mass in der korrelativen Herzbeurteilung verwendet. Diese Untersuchungen wurden später von MUSSHOFF, REINDELL, KLEPZIG und KIRCHHOFF (1956/57, 1958/59) unter Einbeziehung der arterio-venösen Differenz und des Minutenvolumens während Körperruhe und dosierter Belastung bis zur Maximalbelastung im Liegen erweitert. *In diesen Untersuchungen wurde eine lineare Beziehung zwischen dem Herzvolumen im Liegen während Körperruhe einerseits und dem maximalen Schlagvolumen, der maximalen arterio-venösen Differenz* und dem maximalen Minutenvolumen während Belastung andererseits festgestellt. Auch von HOLMGREN (1959) wurde eine gute Korrelation von Herzvolumen und Schlagvolumen bei Arbeit im Liegen gefunden.

Es ist das grosse Verdienst von KJELLBERG, RUDHE und SJÖSTRAND (1949a), mit der Einführung der körperlichen Leistungsfähigkeit — und gleichzeitig des Blutvolumens — als Korrelate des Herzvolumens diese mehr funktionelle Betrachtungsweise in der korrelativen Herzgrössenbeurteilung auf eine breitere Basis gestellt zu haben. Die Verwendung dieser beiden Korrelate, insbesondere der *körperlichen Leistungsfähigkeit*, hat die funktionelle Beurteilung der Herzgrösse ausserordentlich befruchtet. Von uns selbst wird die körperliche Leistung als Korrelat der Herzgrösse seit einigen Jahren verwendet (1956/57, 1958, 1959, 1961).

und pro Pulsschlag bei gesunden Mannern Frauen und Sportlern und die Sicherung der Unterschiede

Herzvolumen cm	Blutvolumen cm	Gesamthaemoglobin g	Maximale O_2 Aufnahme cm	Maximaler O_2 Puls cm
$\bar{X} \pm \sigma$	$\bar{X} \pm \sigma$	$\bar{X} \pm \sigma$	$\bar{X} \pm \sigma$	$\bar{X} \pm \sigma$
927 ± 122 9	5 005 ± 843 8	779 ± 130 9	3 009 ± 515 0	18 0 ± 2 6[illegible]
5 574 **	2 305	1 73[illegible]	3 479 **	3 238 *
80 ± 111 3	4 564 ± 864 5	729 ± 126 4	2 645 ± 359 4	16 1 ± 2 4[illegible]
1 092	1 531		3 114 *	2 105
751 ± 120 3	4 807 ± 918 5		2 361 ± 420 5	14 9 ± 2 33
5 430 *	6 670*	8 949 **	12 116***	10 709 *
605 ± 75 4	3 425 ± 455 0	484 ± 61 8	1 574 ± 266 8	10 1 ± 1 84
14 315*	18 140*	10 70[illegible] *	11 133	13 859

nicht in allen Fallen bestimmt und darum aus statistischen Grunden in die Gesamtbetrachtung nicht mit einbezogen) Die durch Sport bedingte Blutvolumen und Haemoglobinzunahme ist aber relativ gering sie ist beim Blutvolumen nur wahrscheinlich ($P < 0\,05$) und beim Haemoglobin kaum gesichert ($0\,1 > P > 0\,05$) Bei den korperlich leichteren Frauen sind Blutvolumen und Gesamthaemoglobin gegenuber Mannern eindeutig vermindert ($P < 0\,001$)

4 *Korperliche Leistung* Als Maß der Leistung und Kreislaufoekonomie verwendeten wir — wie schon gesagt — die maximale Sauerstoffaufnahme pro Minute und pro Pulsschlag

(a) *Die maximale Sauerstoffaufnahme* (*O_2 Aufn max*) im steady state ist bei Sportlern grosser als bei untrainierten Mannern ($P < 0\,001$) und bei diesen grosser als bei untrainierten Frauen ($P < 0\,001$) Bei den 20—40 jahrigen Mannern ist sie kleiner als bei den 18—19 jahrigen Mannern ($0\,01 < P < 0\,001$) Das bedeutet dass die absolute Leistung der alteren Manner gegenuber den jungeren entsprechend verkleinert ist

(b) *Der maximale Pulssauerstoff* (*O_2 — Puls max*) verhalt sich ahnlich der maximalen Sauerstoffaufnahme pro Minute Die Differenzen zwischen den

Tabelle 1

Korpergewicht, Herz- und Blutvolumen Gesamthaemoglobin und maximale Sauerstoffaufnahme pro Minute

	n	Alter Jahre	Gewicht kg
		$\bar{x} \pm \sigma$	$\bar{x} \pm \sigma$
1 Sportler	44	22 8 ± 4 72	69 6 ± 7 45
t Werte u Sicherung der Unterschiede der Gruppen 1 und 2			0 935
2 Manner 18—19 Jahre	36	18 4 ± 0 5	68 1 ± 6 70
t Werte u Sicherung der Unterschiede der Gruppen 2 und 3			0 756
3 Manner 20—40 Jahre	39	27 3 ± 5 97	66 8 ± 8 05
t Werte u Sicherung der Unterschiede der Gruppen 2 und 4			4 698***
4 Frauen	25	23 5 ± 1 29	60 2 ± 7 95
t Werte u Sicherung der Unterschiede der Gruppen 4 und 1			5 253***

Ergebnisse

I Die Absolutwerte

In der Tabelle 1 sind die Absolutwerte ($M \pm \sigma$) des Korpergewichtes, des Herz und Blutvolumens des Gesamthaemoglobins und der maximalen Sauerstoffaufnahme pro Minute und pro Pulsschlag von Mannern, Frauen und Sportlern, gleichzeitig mit der Sicherung ihrer Unterschiede, zusammengestellt

1 *Das Korpergewicht* (*K G*) ist bei den trainierten und untrainierten Mannern unterschiedlichen Alters gleich Das Gewicht der Frauen ist hochsignifikant geringer

2 *Das Herzvolumen* (*H V*) der Sportler ist grosser als das der untrainierten Manner und dieses wiederum grosser als das der untrainierten Frauen Ein Grossenunterschied zwischen den Herzen der 18—19 jahrigen und 20—40 jahrigen Manner besteht nicht

3 *Das Blutvolumen* (*Bl V*) *und Gesamthaemoglobin* (*Ges Hb*) sind bei Sportlern gegenuber den korperlich gleich schweren Normalpersonen erhoht (In der Gruppe der 20—40 jahrigen Manner wurde das Gesamthaemoglobin

und pro Pulsschlag) und des Blutvolumens (Gesamthaemoglobins) mit dem Korpergewicht

Maximaler O Puls m pro kg Korpergewicht $\left(\frac{O\ Puls\ max}{kg}\right)$			Gesamthaemoglobin g kg Korpergewicht $\left(\frac{Ges\ Hb}{kg}\right)$			Blutvolumen cm pro kg Korpergewicht $\left(\frac{Bl\ V}{kg}\right)$		
cm	Korrelation		g	Korrelation		cm	Korrelation	
M ± σ	r ± εr	P	M ± σ	r ± εr	P	M ± σ	r ± εr	P
0 ?t ± 0 039	0 3?3 ± 0 13?		11 4 ± 1 9?	0 40? 0 12?		72 3 ± 1? 00	0 79? ± 0 138	
			*					
0 ?3 ± 0 0?6	0 624 ± 0 118	**	10 ? ± 1 49	0 548 ± 0 117	*	67 5 ± 9 7?	0 50? ± 0 124	*
						*		
0 ?? ± 0 031	0 546 ± 0 113	**				7? 2 ± 11 6	0 506 ± 0 119	*
* *			*					
0 17 0 048	0 294 ± 0 183		8 1 ± 0 91	0 560 0 13?	*	61 0 ± 6 88	0 3?0 ± 0 1?9	
*			*					

Korrelation (r - 0 6 — 0 7 P < 0 001) (Tab 2) Die Regressionsgeraden sind entsprechend der Unterschiede der Quotienten gegeneinander verschoben (Abb 1)

2 Die Beziehungen zwischen Korpergewicht und Leistungsbreite

Die maximale Sauerstoffaufnahme und der maximale Pulssauerstoff pro kg Korpergewicht sind bei Sportlern grosser als bei untrainierten Mannern im Alter von 18—19 Jahren (P < 0 001) bei diesen grosser als bei untrainierten Mannern im Alter von 20—40 Jahren (0 05 > P > 0 01) und bei diesen wiederum grosser als bei Frauen (P < 0 001)

Die aus den Grossen $\frac{O - Aufn\ max}{K\ G}$ und $\frac{O_2 - Puls\ max}{K\ G}$ gebildeten Quotienten werden dementsprechend von den Sportlern uber die Manner zu den Frauen kleiner (Sicherung der Unterschiede Sportler Manner Frauen = — P < 0 001 Manner 18—19 Jahre Manner 20—40 Jahre = 0 05 > P > > 0 01)

Tabelle 2

Die Beziehungen des Herzvolumens der körperlichen Leistung (der maximalen O_2-Aufnahme pro Minute

	n	Herzvolumen cm³ pro kg Körpergewicht $\left(\frac{HV}{kg}\right)$ cm³ M ± σ	Korrelation r ± εr	P	Maximale O_2-Aufn./min cm³ pro kg Körpergewicht $\left(\frac{O_2\text{-Aufn. max}}{kg}\right)$ cm³ M ± σ	Korrelation r ± εr	P
1. Sportler	44	13.4 ± 1.71	0.560 ± 0.103	***	43.8 ± 8.06	0.164 ± 0.147	
Sicherung der Unterschiede der Gruppen 1 und 2		***			***		
2. Männer 18—19 Jahre	36	11.6 ± 1.26	0.683 ± 0.089	***	38.0 ± 4.15	0.545 ± 0.117	***
Sicherung der Unterschiede der Gruppen 2 und 3		ø			*		
3. Männer 20—40 Jahre	39	11.3 ± 1.53	0.579 ± 0.107	***	3[illegible].5 ± 6.28	0.369 ± 0.139	*
Sicherung der Unterschiede der Gruppen 2 und 4		***			***		
4. Frauen	16	10.1 ± 0.94	0.618 ± 0.121	***	25.2 ± 4.19	0.224 ± 0.190	
Sicherung der Unterschiede der Gruppen 4 und 1		***			***		

Sportlern und jüngeren männlichen Normalpersonen, sowie zwischen den beiden Gruppen der 18—19 jährigen und 20—40 jährigen Männer sind allerdings weniger deutlich.

II. Die Korrelationen

1. Die Beziehungen zwischen Körpergewicht und Herzvolumen

Bei Sportlern ist das Herzvolumen pro Kilogramm Körpergewicht grösser als bei untrainierten Männern und bei diesen grösser als bei untrainierten Frauen. Die Unterschiede der aus beiden Grossen gebildeten Quotienten $\frac{HV}{KV}$ zwischen Frauen, Männern und Sportlern sind hoch gesichert ($P < 0.001$). Ein Unterschied zwischen untrainierten Männern im Alter von 18—19 Jahren und 20—40 Jahren besteht nicht.

Innerhalb der einzelnen Gruppen (Sportler, Männer und Frauen) besteht zwischen den zwei Grossen Körpergewicht und Herzvolumen eine lineare

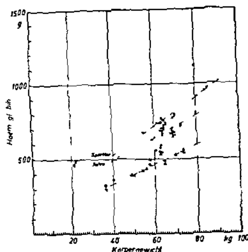


Abb. 3. Die Beziehungen zwischen Körpergewicht und Gesamthaemoglobin (○ = Frauen, + = 18—19 jährige Männer, ● = Sportler)

sind entsprechend der Unterschiede der Quotienten gegeneinander verschoben (Abb. 3). Die Beziehungen des Blutvolumens zum Körpergewicht sind weniger charakteristisch und weniger eng als die Beziehungen des Gesamthaemoglobins zum Körpergewicht. Ursache dieses Verhaltens ist die unterschiedliche Haemoglobinkonzentration des Blutes.

4. *Die Beziehungen zwischen Herzvolumen und körperlicher Leistung*

Im vorliegenden Untersuchungsgut ist der aus Herzvolumen und maximaler O_2-Aufnahme pro Minute und pro Puls gebildete Quotient bei Sportlern und untrainierten Männern im Alter von 18—19 Jahren annähernd gleich. Bei 20—40 jährigen Männern ist er mässig ($0{,}05 > P > 0{,}01$) und bei Frauen erheblich vergrössert ($P < 0{,}001$). Das bedeutet, dass nicht nur die absolute, sondern auch die *relative* pro Herzvolumeneinheit gemessene Leistung bei den Sportlern und 18—19 jährigen Männern am grössten, bei den 20—40 jährigen Männern etwas geringer and bei den Frauen am geringsten ist. Innerhalb der einzelnen Gruppen besteht eine lineare Beziehung zwischen Herzvolumen und maximaler O_2-Aufnahme pro Minute und pro Pulsschlag, die allerdings bei den Frauen infolge einer stärkeren Streuung der Einzelwerte nicht gesichert ist.

Die Korrelationskoeffizienten der Einzelgruppe der Männer betragen $r = 0{,}4$ bis $0{,}7$, des Gesamtgutes $r = 0{,}7$ (Tab. 3). Die Unterschiede der relativen Herzleistung der Sportler und 18—19 jährigen Männer gegenüber den 20—40 jährigen Männern und gegenüber den Frauen wird deutlicher, wenn als Mass der Leistung die maximale Sauerstoffaufnahme und nicht der maximale O_2-Puls verwendet wird.

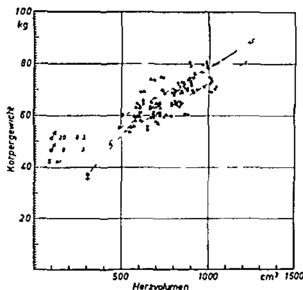


Abb. 1. Die Beziehungen zwischen Korpergewicht und Herzvolumen im Liegen (Frauen ○ — 18—19 jährige Männer □ 20—40 jährige Männer ● Sportler)

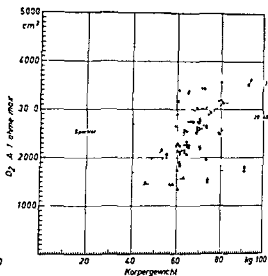


Abb. 2. Die Beziehungen zwischen Korpergewicht und maximaler O_2-Aufnahme im steady state (Frauen ○ — 18—19 jährige Männer □ 20—40 jährige Männer ● Sportler)

Das bedeutet, dass nicht nur die absolute an der O_2-Aufnahme pro Minute und pro Puls gemessene Leistung, sondern auch die relative pro Kilogramm Korpergewicht gemessene Leistung bei den Sportlern am grossten und den Frauen am kleinsten ist. Innerhalb der einzelnen Gruppen besteht zwischen den Grossen Korpergewicht einerseits und O_2-Aufnahme pro Minute und pro Pulsschlag andererseits eine lineare Korrelation, die am engsten bei den untrainierten Männern im Alter von 18 bis 19 Jahren ist. Bei den Frauen und Sportlern ist sie dagegen nur sehr locker und nicht oder nur schwach gesichert (Tab. 2). Die Regressionsgeraden sind, entsprechend der unterschiedlichen Grosse der Quotienten in den einzelnen Gruppen, gegeneinander verschoben (Abb. 2).

3. *Die Beziehungen zwischen Korpergewicht und Blutvolumen und Gesamthaemoglobin*

Bei Sportlern ist die gesamte Haemoglobinmenge pro kg Korpergewicht grosser als bei untrainierten Männern und bei diesen grosser als bei untrainierten Frauen. Der aus beiden Grossen gebildete Quotient $\frac{\text{Ges. Hb}}{\text{K. G.}}$ wird von den Frauen uber die Manner zu den Sportlern grosser (Sicherung der Unterschiede $0.05 > P > 0.01$ bis $P < 0.001$). Innerhalb der einzelnen Gruppen (Frauen, Manner, Sportler) besteht eine gesicherte lineare Beziehung zwischen dem Korpergewicht und der gesamten Haemoglobinmenge, der Korrelationskoeffizient r beträgt 0.4 bis 0.7 (Tab. 2). Die Regressionsgeraden

Minute und pro Pulsschlag) und dem Blutvolumen (Gesamthaemoglobin)

Herzvolumen cm pro cm maximaler O Puls $\left(\frac{HV}{O\ Puls\ max}\right)$			Herzvolumen cm pro gramm Gesamthaemoglobin $\left(\frac{HV}{Ges\ Hb}\right)$			Herzvolumen cm pro cm³ Blutvolumen $\left(\frac{HV}{Bl\ V}\right)$		
cm	Korrelation		cm	Korrelation		cm	Korrelation	
$M \pm \sigma$	$\pm \varepsilon r$	P	$M \pm \sigma$	$r \pm \varepsilon r$	P	$M \pm \sigma$	$r \pm \varepsilon r$	P
5[illegible]2 ± 7 25	0 630 ± 0 031	*	1 [illegible]0 ± 0 [illegible]0	0 575 ± 0 101	*	0 19 ± 0 0[illegible]9	0 523 ± 0 10[illegible]	**
48 9 ± 6 75	0 466 ± 0 130	*	1 09 ± 0 18	0 458 ± 0 13[illegible]		0 17 ± 0 093	0 465 ± 0 131	*
51 1 ± 7 05	0 680 ± 0 086					0 16 ± 0 030	0 45[illegible] ± 0 127	*
*			*					
60 7 ± 8 37	0 356 ± 0 175		1 26 ± 0 14	0 589 ± 0 128		0 17 ± 0 070	0 464 ± 0 154	
	0 693 ± 0 043	*		0 7[illegible]5 ± 0 045	*		0 615 ± 0 05[illegible]	*
y = −3 5 + 0 074 x			y = −2 0 + 0 88 x			y = −1 200 + 400 x		

Korpertraining bedingte Herzvolumenzunahme vergleichsweise ausgepragter als die Zunahme des Blutvolumens und Gesamthaemoglobins ist Die Unterschiede sind allerdings gering und statistisch nur schwach gesichert ($0\ 05 > P > 0\ 01$) Bei untrainierten Mannern und Frauen ist das Herzvolumen pro cm Blutvolumen gleich wahrend der Anteil an Gesamthaemoglobin bei den Frauen verringert ist Ursache ist eine prozentual geringere Haemoglobinkonzentration bei Frauen In allen Gruppen besteht zwischen Herzvolumen und Gesamthaemoglobin und Blutvolumen eine positive lineare Beziehung wobei die Beziehungen zwischen Herzvolumen und Gesamthaemoglobin die engeren sind Der Korrelationskoeffizient des Gesamtgutes betragt fur die Beziehung Herzvolumen Gesamthaemoglobin $r = 0\ 725$ und fur die Beziehung Herzvolumen Blutvolumen $r = 0\ 615$ ($P < 0\ 001$) Die Regressionsgeraden sind geringfugig gegeneinander verschoben (Tab 3 Abb 5)

Tabelle 3

Die Beziehungen des Herzvolumens mit der körperlichen Leistung (der maximalen O_2-Aufnahme pro

		n	Herzvolumen cm³ pro cm³ maximale O_2-Aufnahme/min $\left(\frac{HV}{O_2\text{-Aufn. max.}}\right)$ cm³ M ± σ	Korrelation r ± εr	P
1	Sportler	44	0,31 ± 0,057	0,409 ± 0,126	**
	Sicherung der Unterschiede der Gruppen 1 und 2				
2	Männer 18—19 Jahre	36	0,30 ± 0,044	0,418 ± 0,137	**
	Sicherung der Unterschiede der Gruppen 2 und 3		*		
3	Männer 20—40 Jahre	39	0,32 ± 0,046	0,611 ± 0,100	***
	Sicherung der Unterschiede der Gruppen 2 und 4		***		
4	Frauen	26	0,40 ± 0,065	0,264 ± 0,186	
	Sicherung der Unterschiede der Gruppen 4 und 1		***		
1—4	Gesamtgut			0,735 ± 0,039	***
	Regr. Gleichung des Gesamtgutes		y = —500 + 3,80 x		

Die Unterschiede kommen in einer grösseren Divergenz der Quotienten und der Regressionslinien zum Ausdruck (Abb. 4a). Die Verwendung des maximalen O_2-Pulses, welcher nicht nur die absolute Leistung, sondern auch die Oekonomie der Herzleistung mit berücksichtigt, bewirkt eine Homogenisierung des Untersuchungsergebnisses; die Regressionslinien werden stärker zu einander ausgerichtet (Abb. 4b).

5. *Die Beziehungen zwischen Herzvolumen und Blutvolumen und Gesamthaemoglobin*

Bei Sportlern ist der Herzvolumenanteil pro cm³ Blutvolumen und Gramm Haemoglobin etwas grösser als bei untrainierten Männern. Die aus Herzvolumen und Blutvolumen, sowie aus Herzvolumen und Gesamthaemoglobin gebildeten Quotienten *sind demnach bei Sportlern mit erhöhter Leistung* grösser als bei gleich geschlechtlichen Normalpersonen, so dass die durch

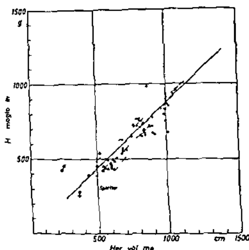


Abb. 5. Die Beziehungen zwischen Herzvolumen und Gesamthaemoglobin (= Frauen, 18—19 jährig. Männer, ● = Sportler. Gesamtregression y = — 2,0 + 0,88 x)

beiden Größen gebildete Quotient wird als Ausdruck dieses Verhaltens in gleicher Weise kleiner. Auch hier wird die unterschiedliche relative Leistung der verschiedenen Gruppen bei Verwendung der maximalen O_2-Aufnahme deutlicher als bei Verwendung des maximalen O_2-Pulses (Tab. 4, Abb. 6).

Diskussion

Die Größe des Herzvolumens ist die Resultante anatomischer und funktioneller Körperfaktoren. Dabei müssen wir zwischen Körperfaktoren unterscheiden, die das Herzvolumen unmittelbar (primär) bestimmen und solchen, die ihrerseits in Abhängigkeit von den die Herzgrösse bestimmenden Faktoren und somit auch in mittelbarer (sekundärer) Beziehung zum Herzvolumen stehen.

Drei Faktoren bestimmen das Herzvolumen gesunder Menschen unmittelbar: (1) das Körpergewicht, (2) das Geschlecht und (3) das Ausmaß körperlicher Bewegung.

1. Die Größe des Herzvolumens wird in erster Linie und unmittelbar vom Körpergewicht bestimmt. Die Abhängigkeit des Herzvolumens vom Körpergewicht ist eine lineare Funktion, die für jugendliche und erwachsene Personen gilt.

Der entscheidende, die Herzgröße bestimmende Faktor des Körpergewichtes ist die Masse der gefäßhaltigen Körperorgane (MÜLLER 1883), vor allem die Skelettmuskulatur (HIRSCH 1899). Der Fettanteil am Gesamtkörpergewicht hat keinen Einfluss auf das Herzvolumen (KAHLSTORF 1932,

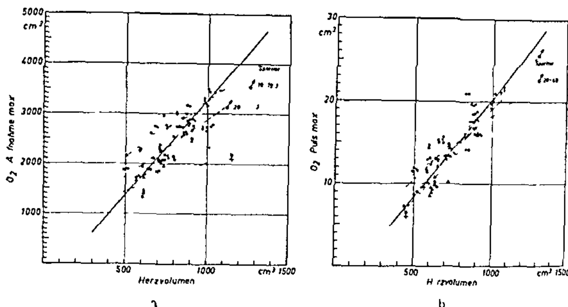


Abb. 4. Die Beziehungen zwischen Herzvolumen und maximaler O_2-Aufnahme (a) und maximalem O_2-Puls (b) (Frauen, 18—19 jährige Männer, 20—40 jährige Männer, ⊙ Sportler. Gesamtregression zu a) $y = -500 + 3{,}80\,x$, zu b) $y = -3{,}5 + 0{,}024\,x$)

6. *Die Beziehungen zwischen Blutvolumen und körperlicher Leistung*

Wir haben unter (4) und (5) gesehen, dass bei gesunden Männern unterschiedlicher Leistungsbreite und unterschiedlichen Alters (bis zum 40. Lebensjahr) und bei gesunden Frauen eine positive Beziehung zwischen dem Herzvolumen einerseits und dem Blutvolumen beziehungsweise der gesamten Haemoglobinmenge und der körperlichen Leistungskapazität andererseits besteht.

Vergleichen wir nun in diesen aus den drei Grossen Herzvolumen, Blutvolumen und Leistung bestehenden Beziehungen die Korrelationen zwischen Blutvolumen und Gesamthaemoglobin einerseits und Leistung andererseits, so sehen wir, wie zu erwarten, auch hier eine positive Korrelation. Diese Korrelationen sind in den Einzelgruppen zwar wesentlich lockerer, entsprechen aber im Gesamtgut den erstgenannten. Der Korrelationskoeffizient beträgt für die Beziehung Gesamthaemoglobin : O_2-Aufnahme max. $= r = 0{,}72$ und für die Beziehung Gesamthaemoglobin : O_2-Puls max. $= r = 0{,}720$. Wird anstatt des Gesamthaemoglobins das Blutvolumen verwendet, so sind die Beziehungen weniger eng. Der Korrelationskoeffizient beträgt für die Beziehung Blutvolumen : maximaler O_2-Aufnahme $= r = 0{,}559$ und für die Beziehung Blutvolumen : maximalen O_2-Puls $= r = 0{,}592$.

Die Leistung pro Einheit Blutvolumen bzw. Gesamthaemoglobin ist nicht in allen Gruppen gleich, sie nimmt von den Sportlern und 18—19 jährigen Männern über die 20—40 jährigen Männer zu den Frauen stetig ab. Der aus

mit dem Blutvolumen (Gesamthaemoglobin)

Maximaler O Puls cm pro gramm Blutvolumen (O Puls max / Bl V)			Maximale O$_2$ Aufnahme/min cm pro cm Blutvolumen (O Aufn max / Bl V)			Maximaler O Puls cm pro cm³ Gesamthaemoglobin (O Puls max / Ges. Hb)		
cm	Korrelation		cm	Korrelation		cm³	Korrelation	
M ± σ	r ± εr	P	M ± σ	r ± εr	P	M ± σ	r ± εr	P
0 0?3 ± 0 00177	0 455 ± 0 128	**	0 6? ± 0 116	0 373 ± 0 129		0 0037 ± 0 00059	0 405 ± 0 126	*
0 0?7 ± 0 00123	0 376 ± 0 143		0 59 ± 0 107	0 284 ± 0 153		0 0035 ± 0 00058	0 354 ± 0 136	
			*			*		
			0 ?6 ± 0 104	0 373 ± 0 143		0 0031 ± 0 00059	0 415 ± 0 133	*
			*			* *		
0 071 ± 0 0044	0 163 ± 0 194		0 45 ± 0 091	0 018 ± 0 ?00		0 0029 ± 0 00058	0 078 ± 0 198	
	0 770 ± 0 046	***		0 ?59 ± 0 054	*		0 597 ± 0 054	**
y = 48 + 0 0?8 x			y = 60 + 0.56 x			y = ? + 0 000275 x		

Männer ist absolut und pro Kilogramm Körpergewicht grösser als das Herz der Frau. Der absolute Unterschied beträgt bei Erwachsenen 150 bis 180 cm³, der relative etwa 1 5 bis 2 5 cm³ pro kg Körpergewicht (vergleiche Ergebnisse KAHLSTORF 1932, BJÖRCK 1944, GREWIN 1949, KJELLBERG u. Mitarb. 1949, MUSSHOFF u. Mitarb. 1956, 1958).

Für die kleinere Grösse der Frauenherzen sind zwei Faktoren verantwortlich.

(a) Bei der Frau ist der Anteil an Fettgewebe am Gesamtkörpergewicht absolut und relativ vermehrt. Da aber das Fettgewebe keinen wesentlichen Einfluss auf die Herzgröße hat, so kann das kleinere Frauenherz als Folge der größeren Fett- und damit geringeren Muskelmasse des Frauenkörpers aufgefaßt werden.

(b) Die zweite Ursache für das kleinere Frauenherz ist eine verminderte

Tabelle 4

Beziehungen der körperlichen Leistung (der maximalen Sauerstoffaufnahme pro Minute und pro Pulsschlag)

		n	Maximale O_2 Aufn./min cm³ pro gramm Gesamthaemoglobin $\left(\frac{O_2\ \text{Aufn./max}}{\text{Ges. Hb}}\right)$		
			cm³	Korrelation	
			$M \pm \sigma$	$r \pm \varepsilon r$	P
1	Sportler	44	3.95 ± 0.742	0.385 ± 0.128	**
	Sicherung der Unterschiede der Gruppen 1 und 2				
2	Männer 18—19 Jahre	36	3.70 ± 0.636	0.291 ± 0.152	
	Sicherung der Unterschiede der Gruppen 2 und 3				
3	Männer 20—40 Jahre	39			
	Sicherung der Unterschiede der Gruppen 2 und 4		*		
4	Frauen	26	3.30 ± 0.640	0.108 ± 0.198	
	Sicherung der Unterschiede der Gruppen 4 und 1		***		
1—4	Gesamtgut			0.728 ± 0.004	***
	Regr. Gleichung des Gesamtgutes		y = 50 + 3.6 x		

Da der entscheidende das Herzvolumen bestimmende Faktor des Körpergewichtes die Muskelmasse ist, wäre die gesamte Muskelmasse des Körpers — gesetzt, dass man sie exakt bestimmen könnte — ein besseres Korrelat für die Normgrosse des Herzens als das Gesamtkörpergewicht.

Der Grad der Korrelation zwischen Körpergewicht und Herzvolumen wird mit zunehmendem Alter lockerer ohne die grundsätzliche Bedeutung zu verlieren. Ursache dieses Altereinflusses ist erstens eine unterschiedliche Zunahme des Fettanteils am Gesamtkörpergewicht und zweitens ein unterschiedlicher Trainingszustand, welcher die Herzgrosse unmittelbar mitbestimmt. Beide Einflüsse werden besonders mit Abschluss des Körperwachstums wirksam.

2. Der zweite Bestimmungsfaktor ist das Geschlecht. Männer haben bei sonst gleichen Voraussetzungen grossere Herzen als Frauen, das Herz der

tion ist bei Frauen weniger eng als bei Männern (in der hier untersuchten Frauengruppe allein nicht gesichert), aber im Gesamtgut hoch gesichert (siehe auch KJELLBERG, RUDHE, SJÖSTRAND 1949, 1954; MUSSHOFF u. Mitarb. 1956/57, 1958, 1958/59; REINDELL u. Mitarb. 1958).

Unter der Einwirkung des körperlichen Trainings auf die Herzgrösse bleibt der mitbestimmende Einfluss der beiden anderen Faktoren des Körpergewichtes und des Geschlechtes auf die Herzgröße grundsätzlich erhalten. Die Abhängigkeit des Herzvolumens vom Körpergewicht wird durch den Einfluss körperlichen Trainings nicht aufgehoben, sondern nur modifiziert. Bei gleicher Leistungssteigerung ist das Herzvolumen des nach Gewicht schwereren Menschen größer als das Herzvolumen eines nach Gewicht leichteren Menschen. Unter Aufrechterhaltung der positiven linearen Korrelation ist die Regressionsgerade von Körpergewicht und Herzvolumen beim Sportler zugunsten des Herzvolumens verschoben.

Nur wenn in einem Kollektiv von Sportlern der Trainingszustand und die Leistungsbreite *sehr unterschiedlich sind, wie es in einem früher von uns veröffentlichten Untersuchungsgut* unterschiedlichster Leistungskapazität der Fall war, kann die Korrelation Herzvolumen/Körpergewicht entsprechend den Unterschieden der Leistungsbreite mehr oder weniger aufgelockert sein (MUSSHOFF u. Mitarb. 1958). Werden die Sportler nach ihrer Leistung in Gruppen gleicher oder ähnlicher Leistung geordnet, wird die ursprüngliche Beziehung zwischen Körpergewicht und Herzvolumen wieder besonders deutlich (ROSKAMM, REINDELL, MUSSHOFF, KÖNIG 1961).

Der Einfluss des Geschlechts auf die Beziehung von Herzvolumen und Leistung wurde schon im vorangehenden Abschnitt beschrieben: der maximale Sauerstofftransport pro Herzvolumeneinheit ist bei der Frau signifikant geringer als beim Manne. Das Herz der Frau ist somit bei gleicher Größe weniger leistungsstark als das Herz des gleichaltrigen Mannes.

Die Beziehung der beiden Größen Herzvolumen und Leistung zueinander wird vom Alter beeinflußt und verändert. Mit dem dritten Lebensjahrzehnt nimmt die Leistungsbreite ab, während das Herzvolumen gleich bleibt. Wir haben an anderer Stelle zeigen können, daß die absolute Leistung auch jenseits des hier untersuchten Lebensalters weiter abnimmt, so daß bei gleichbleibender Herzgröße die Divergenz von Leistung und Herzvolumen weiter zunimmt (KÖNIG u. Mitarb. 1961). Durch dieses divergente Verhalten der Herzgröße und Leistung jenseits des 20. Lebensjahres wird die Leistung des Herzens, gemessen am Quotienten Herzvolumen/maximale O_2-Aufnahme, zunehmend kleiner. Das bedeutet, daß mit abgeschlossenem Körperwachstum das Alter negativ inotrop auf die Herzleistung einwirkt.

Die maximale Sauerstoffaufnahme pro Minute ist ein quantitativ und qualitativ geeignetes Maß der absoluten Herzleistung. Den aus Herzvolumen und maximaler Sauerstoffaufnahme pro Minute gebildeten Quotienten kann man als spezifischen Leistungsgradienten des Herzvolumens bezeichnen, der die spezifische (nicht absolute) Leistung, das heißt die Leistung pro cm^3 Herzvolumen anzeigt. Die spezifische Leistung des Herzens ist umso größer, je kleiner der Quotient ist.

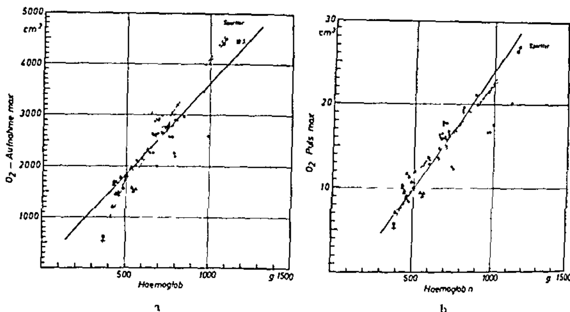


Abb. 6. Die Beziehungen zwischen Gesamthaemoglobin und maximaler O_2-Aufnahme (a) und maximalem O_2-Puls (b). (Frauen, 18—19 jährige Männer, ● Sportler. Gesamtregression zu a) $y = 50 + 3,6\,x$. Gesamtregression zu b) $y = -4,0 + 0,023\,x$)

Leistung des Frauenkörpers, welche — wie im folgenden dargelegt wird — die Herzgröße mitbestimmt. Die Leistung der Frau ist gegenüber derjenigen des Mannes absolut und relativ pro Kilogramm Körpergewicht vermindert.

Die Leistung der Frau ist aber nicht nur im Vergleich zum Körpergewicht, sondern auch im Vergleich zur Herzgröße vermindert. Das Herz der Frau leistet pro Kubikzentimeter Herzvolumen weniger als das Herz des Mannes. Das bedeutet, daß hier ein spezifisch geschlechtsbedingter inotroper Einfluß auf das Herz wirksam ist, und zwar bei der Frau im Sinne einer negativ inotropen Einwirkung.

3. Die dritte Bestimmungsgröße des Herzvolumens ist das Ausmaß körperlicher Bewegung. Körperliches Training durch Sport und Schwerarbeit, welches zu einer Leistungssteigerung führt, vergrößert das Herzvolumen. Personen mit erhöhtem Leistungsvermögen (Sportler, Schwerarbeiter) haben bei gleichem Körpergewicht ein größeres Herzvolumen als Personen mit normaler Leistungskapazität und diese wiederum ein größeres Herzvolumen als Personen mit vermindertem Leistungsvermögen. (Die Kapazität für körperliche Leistung ist bei normal gewachsenen Personen vom Körpergewicht (siehe auch WAHLUND 1948) und vom Ausmaß körperlichen Trainings abhängig.)

Zwischen dem Leistungsvermögen des Körpers und Kreislaufes und der Größe des Herzvolumens besteht eine lineare Korrelation: je größer das gesunde, normal große und das durch Sport und Schwerarbeit physiologisch vergrößerte Herz ist, umso größer ist sein Leistungsvermögen. Die Korrela-

der Beziehung Gesamthaemoglobin/Herzvolumen betragt sowohl bei SJOSTRAND als auch bei uns 0 5 bis 0 6 Nach den Befunden von SJOSTRAND ist diese Beziehung zwischen Korpergewicht und Gesamthaemoglobin bei Knaben und Madchen enger als bei erwachsenen Männern und Frauen (Dabei ist aufschlußreich, daß die Beziehung des Blutvolumens zur Korperoberflache sehr viel schlechter ist als die Beziehung des Blutvolumens zum Korpergewicht (HOLMGREN 1959)) Durch korperliches Training wird die absolute Haemoglobinmenge und der Haemoglobingehalt pro Kilogramm Korpergewicht großer Die direkte Beziehung zwischen Korpergewicht und Haemoglobinmenge wird bei Sportlern lockerer bleibt aber im Grundsatzlichen erhalten die Regressionsgerade wird zugunsten der Haemoglobinmenge verschoben

Es ergeben sich somit bei Mannern Frauen und Sportlern sehr ahnliche Beziehungen zwischen dem Korpergewicht einerseits und dem Herzvolumen der Kapazitat fur korperliche Leistung und der gesamten Haemoglobinmenge andererseits Bei gesunden normal entwickelten Menschen sind das Herzvolumen die Kapazitat fur korperliche Leistung und die gesamte Haemoglobinmenge unmittelbare Funktionen des Korpergewichtes Alle drei Beziehungen werden durch das Geschlecht und das Ausmaß korperlichen Trainings in gleicher Weise beeinflußt

a) Bei Frauen sind das Herzvolumen, die Leistung und das Gesamthaemoglobin gegenuber Mannern absolut und pro Kilogramm Korpergewicht hochsignifikant vermindert

b) Durch korperliches Training werden das Herzvolumen die Kapazitat fur korperliche Leistung und die gesamte Haemoglobinmenge absolut und pro Kilogramm Korpergewicht vermehrt

Nach dieser ahnlichen Abhangigkeit des Herzvolumens der Leistung und des Gesamthaemoglobins vom Korpergewicht bei Mannern Sportlern und Frauen ist ein gleichsinniges Verhalten nicht nur der beiden vom Korpergewicht abhangigen Großen Herzvolumen und Leistung miteinander — wie schon dargelegt wurde — sondern auch der abhangigen Großen Herzvolumen und Gesamthaemoglobin sowie Leistung und Gesamthaemoglobin in allen drei Untersuchungsgruppen zu erwarten

Diese Beziehungen wurden schon — wie eingangs erwahnt — in eingehenden Untersuchungen der Stockholmer Schulen mit einer anderen Methode der Blutvolumen und Leistungsbestimmung bestimmt

In diesen Untersuchungen wurde von KJELLBERG u Mitarb (1949 a und c) bei Kindern Mannern Frauen und Athleten und von LIND (1950) bei Sauglingen festgestellt daß zwischen Herzvolumen und Gesamthaemoglobin eine lineare Korrelation besteht deren Korrelationskoeffizient in allen Gruppen zwischen 0 96 und 0 99 gelegen ist

Von NYLIN (1957) wurde die positive Korrelation zwischen Herzvolumen und Blutvolumen welches mit der radioaktiven Markierung der Erythrocyten

Während die maximale Sauerstoffaufnahme jenseits des zweiten Lebensjahrzehntes analog der absoluten Leistung abnimmt, ist der maximale O_2-Puls bis zum 60. Lebensjahr, wie wir an anderer Stelle (KÖNIG u. Mitarb. 1961) *haben zeigen können, vom Alter unabhängig.* Das hängt damit zusammen, daß im Alter die Leistung (O_2-Aufnahme max.) und die maximale Frequenz in gleicher Weise abnehmen. Die Konstanz des maximalen O-Pulses im Alter besagt, daß der Sauerstofftransport pro Pulsschlag *(nicht pro Minute) unverändert bleibt.* Da andererseits das Schlagvolumen im Alter abnimmt, muß geschlossen werden, daß die arteriovenöse Ausschöpfung der Peripherie in gleichem Maße zunimmt. Mit anderen Worten: die maximale Sauerstoffaufnahme pro Puls ist nur in einem begrenzten Zeitabschnitt Ausdruck der absoluten Leistungsbreite des Herzens. Mit Einsetzen der physiologischen, durch eine eingeschränkte Leistungsbreite charakterisierten Altersinsuffizienz wird der maximale Pulssauerstoff immer weniger ein Maß der absoluten Leistung und zunehmend ein Maß kompensatorischer Vorgänge zum Ausgleich der altersbedingten Involution.

Die durch physisches Training verursachte Herzvergrößerung, die mit einer Leistungssteigerung einhergeht, ist durch ein harmonisches Wachstum der Muskulatur und der Herzhöhlen bedingt. Die Relation von Muskelmasse und Blutfüllung bleibt erhalten (LINZBACH 1956, 1958, MUSSHOFF, REINDELL, KLEPZIG & KIRCHHOFF 1956/57). Die Leistungsreserve des regulativ oder physiologisch vergrößerten Herzens ist vergrößert. Diese und die gleichlautenden Befunde von KJELLBERG, RUDHE & SJÖSTRAND *(1949)* und unserer früheren Untersuchungen widerlegen die auf den klassischen Herzgesetzen von FRANK, STRAUB & STARLING fußende Auffassung, daß die Reservekraft des Herzens mit zunehmender Herzvergrößerung in jedem Falle abnimmt und sich immer mehr dem Grenzbereich der Insuffizienz nähert. Das Gesetz *gilt in dieser Form nur für die pathologische nicht für die physiologische* Herzvergrößerung. Es gilt in gewisser Weise (in reziproker Betrachtung) auch für das Altersherz, dessen Leistung bei gleicher Größe vermindert ist („physiologische Altersinsuffizienz" von WEZLER und SPANG). Diese Befunde sprechen dafür, dass es sich bei der physiologischen Altersinsuffizienz um eine echte Insuffizienz handelt.

Neben den drei das Herzvolumen unmittelbar und primär bestimmenden Faktoren — Körpergewicht, Geschlecht und das Ausmaß körperlichen Trainings — müssen wir Körperfaktoren unterscheiden, die *ebenfalls in eigener* Abhängigkeit von diesen das Herzvolumen unmittelbar bestimmenden Faktoren und somit in gleicher oder ähnlicher Beziehung auch zum Herzvolumen stehen, dieses aber nicht selbst unmittelbar beeinflussen. Diese Beziehungen des Herzvolumens sind nach dem Satze zu verstehen: sind zwei Größen einer dritten *gleich, so* sind sie auch untereinander gleich.

Bei gesunden erwachsenen Männern und Frauen normaler Leistungsbreite ist die gesamte Haemoglobinmenge vom Körpergewicht abhängig. In Übereinstimmung mit Befunden, die SJÖSTRAND *(1949)* an einem *grösseren Unter*suchungsgut mit der Kohlenmonoxydmethode erhoben hat, besteht eine direkte Beziehung zwischen Körpergewicht und Gesamthaemoglobin, wobei beim Manne die Haemoglobinmenge absolut und pro Kilogramm Körpergewicht signifikant größer ist als bei der Frau, der Korrelationskoeffizient r

(1937 1938) über die Beziehungen zwischen dem Körpergewicht und dem Herzgewicht und den Großen Gefäßen sondern auch die Untersuchungsergebnisse von SJÖSTRAND über die Beziehungen zwischen dem Körpergewicht und der gesamten Haemoglobinmenge bei Jugendlichen und Erwachsenen im Wachstumsalter vollzieht sich die Entwicklung des Herzens, der großen Gefäße und der gesamten Blutmenge in enger Abhängigkeit vom Körpergewicht Hand in Hand mit der Körperentwicklung, während des Wachstums geht die Ausbildung der Leistungsbreite

Der differenzierende Einfluß des Geschlechts auf das Herz und Blutvolumen (Gesamthaemoglobin) ist für den Zeitraum von 5 bis 12 Jahren anzunehmen Das bis dahin bei beiden Geschlechtern gleiche proportionale Herzgewicht (Herzgewicht pro Kilogramm Körpergewicht) wird nach den großen Reihenuntersuchungen von MÜLLER (1883) und ROESSLE & ROULET (1932) in der Zeit vom 5 bis 10 Lebensjahr beim männlichen schwerer als beim *weiblichen Geschlecht* Nach den Untersuchungen von SJÖSTRAND (1949) wird die gesamte Haemoglobinmenge im Alter von 8 bis 12 Jahren bei den Knaben größer als bei den Mädchen

Durch ein unterschiedliches Ausmaß körperlicher Bewegung welches im allgemeinen nach abgeschlossenem Körperwachstum einsetzt werden die Kapazität für körperliche Leistung das Herzvolumen und die gesamte Haemoglobinmenge bzw das Blutvolumen verändert Durch vermehrte körperliche Tätigkeit (Sport Schwerarbeit) werden die Leistungskapazität das Herzvolumen und das Gesamthaemoglobin absolut und pro Kilogramm Körpergewicht größer durch verminderte körperliche Tätigkeit (vorwiegend ruhende und sitzende Tätigkeit) werden sie kleiner

SUMMARY

Heart volume (H V) blood volume/total haemoglobin (Bl V) and bodily efficiency (O intake max O_2 pulse max) are in healthy subjects firmly related to the factors of body weight (kg) sex and muscular activity (sport heavy labour) The factors

$$\frac{H\ V}{kg} \quad \frac{Bl\ V}{kg} \quad \frac{O_2 \text{ intake max}}{kg} \text{ and } \frac{O_2 \text{ pulse max}}{kg}$$

are smaller in females and are all increased by vigorous muscular exercise they are also increased although *not all* quite in the same proportion through physical training

ZUSAMMENFASSUNG

Herzvolumen (H V) Blutvolumen Gesamthaemoglobin (Bl V) und Leistungsfähigkeit (O Aufn max O_2 Puls max) werden bei gesunden Personen vom Körperg wicht (Kg) Geschlecht und Ausmaß körperlicher Bewegung (Sport Schwerarbeit) bestimmt Die Faktoren

$$\frac{H\ V}{Kg} \quad \frac{Bl\ V}{Kg} \quad \frac{O_2\text{-Aufn max}}{Kg} \text{ und } \frac{O_2 \text{ Puls max}}{Kg}$$

(pro Kg Körpergewicht) werden durch das Geschlecht — weibliches gegenüber männlichem — verkleinert und durch intensive körperliche Bewegung vergrößert Die Zunahme durch körperliches Training vollzieht sich annähernd aber nicht mit absoluter Genauigkeit gleich

gewonnen wurde, bestätigt, allerdings ohne diesen engen Grad der Korrelation. Auch in unserem Untersuchungsgut und mittels unserer Methode besteht bei Männern, Frauen und Sportlern eine lineare Beziehung zwischen Herzvolumen und Gesamthaemoglobin, der Grad der gegenseitigen Bindung ist aber ebenfalls weniger eng, als er von KJELLBERG u. Mitarb. sowie LIND gefunden wurde: die Korrelationskoeffizienten betragen in den einzelnen Gruppen r = 0,46 bis 0,59 und im Gesamtgut r = 0,725.

In Übereinstimmung mit KJELLBERG u. Mitarb. ist das Herzvolumen pro Gramm Gesamthaemoglobin bei Frauen deutlich größer als bei Männern, die Regressionsgerade ist dementsprechend bei Frauen etwas zugunsten des Herzvolumens verschoben. Wird in die Beziehung Herzvolumen/Gesamthaemoglobin anstelle des Gesamthaemoglobins das Blutvolumen eingesetzt, so fällt dieser Unterschied zwischen Männern und Frauen fort. Der Quotient Herzvolumen/Blutvolumen ist bei beiden Geschlechtern identisch. Ursache dieses divergenten Verhaltens in der Beziehung Herzvolumen zu Gesamthaemoglobin und Blutvolumen ist der geringere prozentuale Haemoglobingehalt der Frau. Im übrigen ist die Beziehung des Herzvolumens zum Blutvolumen etwas weniger eng als zum Gesamthaemoglobin, ein Befund auf den schon KJELLBERG u. Mitarb. hingewiesen haben.

In dem schon genannten gleichen Untersuchungsgut von Kindern, trainierten und untrainierten Männern und Frauen, fanden KJELLBERG (1949, a und c) ebenfalls eine enge positive Beziehung zwischen der Leistungsbreite (Leistungstest nach WAHLUND) und der gesamten Haemoglobinmenge (Kohlenmonoxydmethode nach SJÖSTRAND), bzw. dem Blutvolumen (r = 0,90 ± ± 0,01).

Mit derselben Methode der Haemoglobinbestimmung fand ÅSTRAND (1952) bei wohltrainierten männlichen und weiblichen Versuchpersonen im Alter von 4 bis 30 Jahren eine sehr enge Beziehung des Gesamthaemoglobins zur maximalen Sauerstoffaufnahme pro Pulsschlag (r = 0,976) und zur maximalen Sauerstoffaufnahme pro Minute (r = 0,970).

Wir selbst fanden bei unserem Untersuchungsgut von Männern, Frauen und Sportlern ebenfalls eine positive Beziehung zwischen maximaler Sauerstoffaufnahme pro Pulsschlag und pro Minute einerseits und dem Gesamthaemoglobin und dem Blutvolumen andererseits. Die kleineren zwischen 0,559 und 0,728 gelegenen Korrelationskoeffizienten ergeben aber eine weniger enge gegenseitige Beziehung als bei den mit der Kohlenmonoxydmethode erhobenen Befunden. Und auch hier ergeben sich einige deutliche Größenunterschiede der Quotienten der verschiedenen Untersuchungsgruppen.

Die geschilderten Zusammenhänge weisen darauf hin, daß im Wachstumsalter das Körpergewicht der primär bestimmende Faktor für die Entwicklung des Herzens, der großen Gefäße und des Blutvolumens (Gesamthaemoglobins) ist. Dafür sprechen nicht nur die pathologisch-anatomischen Befund von SCHIELF WIEGAND (1880), RÖSSLE & ROULET (1932), und MEYER u. Mitarb.

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Le volume cardiaque (H. V.), le volume sanguin/l'hémoglobine totale (Bl. V.) et le rendement corporel (fixation max. d'O, rejet max. d'O_2) sont chez le sujet sain étroitement liés aux facteurs poids corporel (kg), sexe et activité musculaire (sport, travail de force).
Les rapports

$$\frac{\text{H. V.}}{\text{kg}},\quad \frac{\text{Bl. V.}}{\text{kg}},\quad \frac{\text{fixation max. d'}O_2}{\text{kg}}\ \text{et}\ \frac{\text{rejet max. d'}O_2}{\text{kg}}$$

sont plus petits chez la femme et augmentent tous au cours de l'exercice musculaire intense; *ils augmentent aussi, mais pas tous* dans la même proportion, sous l'effet de l'entraînement physique.

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PERCUTANEOUS SELECTIVE ANGIOGRAPHY OF THE INFERIOR MESENTERIC ARTERY

by

BERTIL G STROM and THOR WINBERG

The roentgenologic differential diagnosis between carcinoma and an inflammatory condition in stenosis of the sigmoid colon usually presents little difficulty It may however at times be impossible to exclude malignancy with the more conventional types of examination and it is then that a supplementary method such as percutaneous selective angiography of the inferior mesenteric artery may be of considerable value

A thin radiopaque polythene small catheter (green Ödman catheter) with a preformed tip (Fig 1) is introduced into the inferior mesenteric artery via the femoral artery and aorta by the Seldinger method In 80 % of cases the inferior mesenteric artery originates from the left anterior wall of the aorta at the level of the body of L3 or the L3—L4 joint The first part of its course is directed more or less forwards and then downwards so that it comes to run parallel to the aorta The particular bend given to the tip is designed to facilitate its suction by the blood stream into the mouth of the vessel when the tip is in the vicinity of the artery The caudally directed part of the catheter must not be longer than 1 cm When introduced into the femoral artery and the aorta the catheter is straightened by the guide wire and when the wire is removed the catheter resumes its preformed bend If the caudally directed part of the cathe

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Fig 3 Adenocarcinoma of descending colon Upper right view wide draining veins begin to fill from contrast loaded tumor (arrows)

caliber of the inferior mesenteric artery The patient feels a warm sensation in the lower part of the abdomen and in the perineum as the contrast medium is injected

When the examination is to be performed with special reference to the sigmoid colon the patient is positioned obliquely with the right side up in order to obtain the best projection of that part of the bowel We have usually introduced gas into the bowel immediately prior to the injection of contrast medium

Two roentgen tubes at a 10 interangle are used in these selective angiographies and are operated alternately so that every other film is exposed by the first tube and the others by the second tube Each pair of films may consequently be viewed stereoscopically and minor changes better judged Even if the stereoscopic effect is not u ed the small parallax between the films makes it possible to obtain better differentiation of small details The films are exposed



Fig 1 Specially shaped tip of small Ödman catheter

ter is larger than the internal diameter of the aorta, the catheter cannot resume its original shape In addition to the bending of the tip we form two large bows in the catheter, to minimize tension in the vessels and make manoeuvering easier These bows are made to conform to the caudal part of the abdominal aorta and the sacral curvature of the common iliac and external iliac arteries (Fig 2)



Fig 2 Oblique view Curvature of caudal part of abdominal aorta and sacral bow of common and external iliac arteries Inferior mesenteric artery faintly outlined (arrow)

The tip of the catheter is introduced into the inferior mesenteric artery under fluoroscopic control We used a Muller BV 20 image intensifier in the first catheterizations This was however cumbersome, and the screen image was unsatisfactory in obese subjects Later *we had the advantage of collaborating* with Professor Wallman of Chalmers Institute of Technology, Gothenburg, and then adopted an image intensifier television combination developed by them This combination includes a French made Houston image intensifier and a Vidicon camera with an interposed optical system Due to several refinements, it is possible to obtain a satisfactory image on the monitor screen with a screening current of 1 to 2 mA and 70 kV The skin dose rate even in thick subjects is only 0 1 to 0 5 r per minute Among the advantages of this apparatus are the possibility of working in a lighted room and the easy positioning of the monitor screen for comfortable viewing

The contrast medium we used was Urografin 60 %, satisfactory vascular contrast filling is obtainable with 10 ml but we usually use a little more The *injection* of the medium is always made by hand, and with the small amounts employed this has proved to be quite satisfactory To increase the injection rate by means of a pressure injector is of little value because of the small

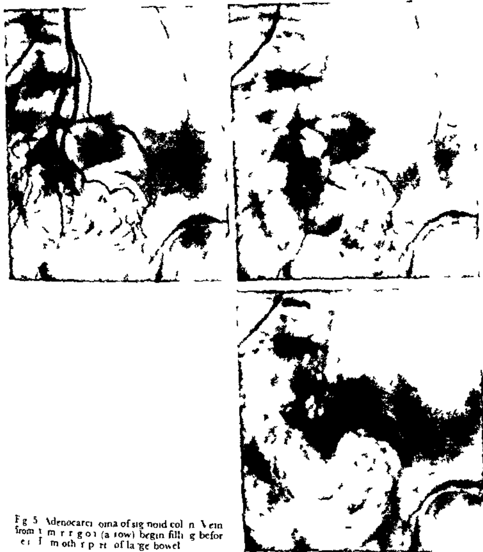


Fig 5 Adenocarcinoma of sigmoid colon Vein from tumor region (arrow) begin filling before veins from other parts of large bowel

These veins were filled with contrast medium earlier than veins of other parts of the large bowel findings which are characteristic of a tumor rich in vessels (Figs 3 and 4)

Tumors situated in the sigmoid colon are more difficult to demonstrate because of the tortuous course and the intrapelvic position of this part of the bowel The beam direction is axial to a part of the colon and in addition the bowel is always *superimposed* over the bony pelvis There is therefore less possibility to make a detail study of small changes in the vessels in the sigmoid



Fig 4 Adenocarcinoma of descending colon Irregular tumor loaded with medium Draining veins with early filling (arrow) c) Well filled very large veins from tumor

at the rate of four films per second during the first 2 to 3 seconds while during the later phases of the circulation a pair of films is generally exposed every other second The time interval between the first and the last film is about 20 seconds

Material To date we have performed percutaneous selective angiography of the inferior mesenteric artery on 22 occasions in 21 cases

In 5 other cases we were unable to place the catheter tip in the mouth of the artery These were all represented by old subjects, with a high degree of tortuosity of the iliac vessels, making proper manipulation of the catheter impossible

Of the 22 successfully performed catheterizations, two were made en passant during selective catheterization of the coeliac artery, this being possible only if the aorta and the inferior mesenteric artery are sufficiently wide Angiographic examination of the descending and sigmoid colon was incomplete in these two instances and 2 cases are therefore not suitable for inclusion in the series Of the remaining 20 catheterizations, two were found to be cases of tumor in the descending colon, both histologically proved adenocarcinomas, revealed by projecting the pathologically changed part of the bowel free from other parts of the intestine and from the skeleton It was also possible to demonstrate angiographic changes, consisting of wide feeding arteries, irregular and tortuous tumor vessels accumulation of contrast medium in the tumor and rapid passage of the medium through the tumor into wide draining veins

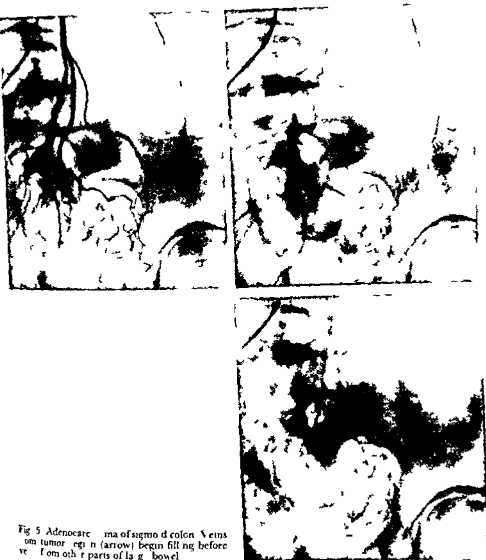


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a

b c d

Fig. 6. Adenocarcinoma of sigmoid colon. a) Barium enema. c) Early filling of wide draining veins (arrows).

region than other parts of the intestine. Of the characteristic vascular changes mentioned above, the most reliable in sigmoid tumors is the rapid passage of contrast medium into the wide draining veins. The difficulty of the superimposed pelvic bones may largely be eliminated by using the so called subtraction method described by ZIEDSES DES PLANTES. However, difficulties caused by the tortuous course of the sigmoid colon have not yet been overcome.

In 17 of our cases, the changes were in the sigmoid colon

In 8 of these they were due to adenocarcinoma, histologically verified In six of the latter eight cases we could demonstrate that the veins draining from the pathologically changed parts of the bowel filled earlier than did veins from other parts of the bowel but in the remaining two cases which however technically were not satisfactory no such early filling was seen In seven of the eight cases of adenocarcinoma the histologic diagnosis varied from a low to a rather high degree of differentiation, and in the remaining one it was an adeno papillary polyp with transition to carcinoma

Of the remaining 9 cases two were histologically verified as being cases of diverticulitis with peridiverticulitis One was a case of endometriosis of the sigmoid colon and one a case with inflammatory changes in the sigmoid colon and perisigmoid region and metastases from a melanoma in the inguinal lymph glands, the primary tumor could not be found at autopsy In another case an inflammatory tumor, the size of a hen s egg was found in the sigmoid colon at operation but no biospy was taken The other cases have not been operated upon In none of the now mentioned nine cases was there any early contrast filling of draining veins

Discussion

Selective angiography of the inferior mesenteric artery has previously been performed by BIERMANN et coll and MORINO et coll who introduced the catheter in an antegrade direction via the brachial or common carotid artery after exposing and incising the vessel In the material published by BIERMANN et coll 2 of the 16 cases developed hemiplegia when the common carotid artery ap proach was u ed In 5 cases the brachial artery was used as an entrance point and in one of these thrombosis occurred

We have chosen percutaneous puncture via the femoral artery because the risk of complications is less by reason of the thicker vessel wall and larger caliber of the vessel and because the sequela of a complication e g a throm bosis is less dangerous MCAFEE has published a review of complications from inferior mesenteric arterial injection during translumbar aortograms In his material the needle tip would occasionally lie in the inferior mesenteric artery and gangrene of the bowel following injection of contrast medium would sometimes occur We have had no complications in our cases

BIERMANN et coll mentioned successful catheterization of the inferior mes enteric artery but the use of the method for a diagnostic purpose was not described In order to obtain roentgen films of the vessels and bowel SCHO BINGER et coll performed angiography following laparotomy This method entails several disadvantages First it does not allow sufficient time for studying the films The value of the examination is greater if the films are available before the operation when the anatomy of the vessels may be evaluated and then the extent of the resection can be planned in advance Secondly the



Fig 7 Adenopapillary cancerous *polyp of lower sigmoid colon Wide draining veins with early filling* (arrows)

roentgen equipment, including a film changer necessary for satisfactory angio graphy, is usually not available in the operating theatre For these reasons we believe that preoperative examination in the roentgen department is preferable to operative angiography

As our material is limited, we have not found it possible to draw any definite conclusions from differences observed between the angiographic appearances of inflammatory lesions and malignant tumors We could, however, demon strate a rapid contrast filling of veins from a pathologically changed part of the sigmoid colon in six of our cases, in all of which an adenocarcinoma was subsequently found, but early filling of draining veins was not obtained in any of the cases of histologically verified inflammatory lesions of the sigmoid colon Nor could any early filling of the veins be demonstrated in two cases with adenocarcinoma of the sigmoid colon, but the examination was technically suboptimal in both these cases and, in particular, a satisfactory venous phase was not obtained We therefore believe it possible that an angiographic dif ferential diagnosis between inflammatory lesions and malignant tumors of the sigmoid colon may eventually become established A correlation of pre operative selective angiography, with angiography of the morbid specimen and histologic examination will necessarily be required

Preoperative angiography, apart from the diagnostic value of the method has proved of help in planning the operation Knowledge of the anatomy of the vascular supply of the bowel obviously facilitates the selective resec-

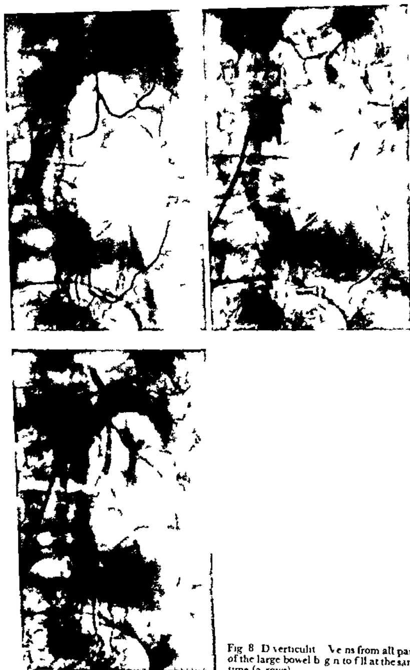


Fig 8 D verticulit Ve ns from all parts of the large bowel b g n to f ll at the same time (a rows)

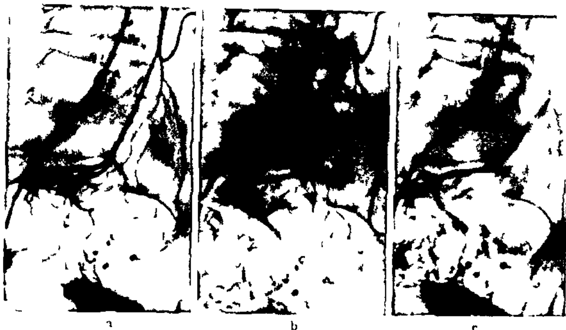


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FROM THE DEPARTMENT OF DIAGNOSTIC ROENTGENOLOGY (DIRECTOR BJORN NORDENSTROM) THORAXKLINIKEN KAROLINSKA SJUKHUSET STOCKHOLM, SWEDEN

BALLOON CATHETERS FOR PERCUTANEOUS INSERTION INTO THE VASCULAR SYSTEM

by

BJORN NORDENSTROM

Various types of cardiac catheters have for a long time been extremely useful for the physiologic and roentgen diagnostic investigation of the heart and vascular system

One of the most important improvements in the catheterization technique has undoubtedly been the percutaneous method of insertion of simple catheters as developed by SELDINGER (1952) By this method the possibilities of utilizing the diagnostic advantages of clinical catheterization of arteries and veins have been considerably increased

The first catheter that could be utilized for diagnostic unilateral occlusion of the pulmonary arteries in animals and man was described as early as 1951 (CARLENS et coll) A series of different types of balloon catheters was introduced in 1954 (NORDENSTROM) These were all constructed for introduction through an incision in the wall of the vessel In spite of this however balloon catheters have been employed to a fairly large extent in the diagnosis of cardiac and vascular lesions

A considerable advantage would be obtained if balloon catheters could be introduced percutaneously and attempts have been made at our clinic to solve the problem The design of the five types of balloon catheters tested appear from the schematic drawings in Fig 1

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tion of the latter Furthermore, the tying of the necessary vessels at their origin from the inferior mesenteric artery, and the removal of associated lymph glands, must do much to obviate the surgical implantation of latent metastases and consequently improve the prognosis

SUMMARY

The value of percutaneous selective angiography of the inferior mesenteric artery with reference to a material of 21 cases is discussed and the technique described

ZUSAMMENFASSUNG

Der Wert von perkutaner selektiver Angiographie der Art mesenterica inf wird an Hand eines Materiales von 21 Fallen besprochen und die Technik beschrieben

RÉSUMÉ

Se basant sur une série de 21 cas les auteurs décrivent la technique de l angiographie sélective percutanée de l artère mésentérique inferieure et montrent son intéret

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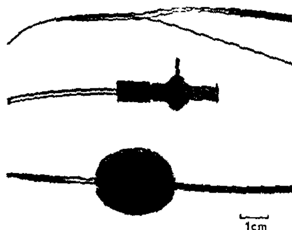


Fig 2 Roentgenograms of a balloon catheter type II for percutaneous insertion before and after insufflation of the balloon A flexible steel wire is introduced through the tip of the catheter and taken out through the side hole distal to the balloon

of the catheter The weakening of the catheter at the site of the balloon may sometimes increase the difficulty of introducing the former into the vessel without kinking it This drawback may however be overcome if a steel wire is inserted into the lumen of the catheter and advanced to a point beyond the weak part

Catheter type III is constructed for the injection of contrast medium distal to the balloon, part of the injected medium will distend the balloon, and part will disappear in an axial direction through the tip of the catheter and the side hole close to the balloon

Catheter type IV is characterized by the arrangement of two balloons on the same catheter the intention being to produce double blocking Contrast medium may be injected between the balloons by an extra catheter which is placed in the vessel outside the balloon catheter with the tip between the balloons

Catheter type V is constructed for the injection of contrast medium proximal to the balloon The injection produces distension of the balloon as in the catheter type III

The catheters are introduced into the vessel by the Seldinger technique more or less in the same way as a single lumen catheter After percutaneous puncture of the vessel a No 160 flexible steel wire is introduced through the puncture needle which is then removed The balloon catheter is then threaded on to the steel wire as shown in Fig 2 and pushed into the vessel after all air has been pressed out of the balloon

This technique has proved very satisfactory when the catheter has been introduced into larger vessels e g a femoral vein When the catheter is introduced into a small vessel it is sometimes required not to introduce the wire alongside with the balloon This may be effected by utilizing a catheter

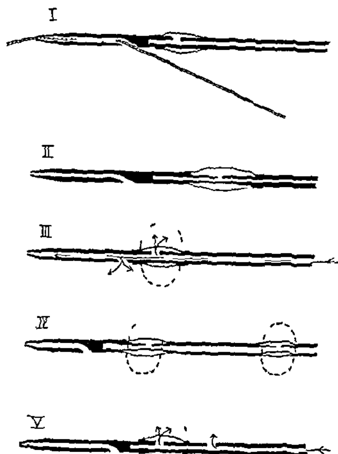


Fig. 1. Five different types of balloon catheters for percutaneous insertion into the vessels. Type I provided with a small balloon for simple occlusion. Type II tapered down at the site of the large balloon. Type III for injection of contrast medium distal to the balloon which will be distended during the injection. Type IV for double blockage of a vessel. Type V for injection of contrast medium proximal to the balloon which will be distended by the injection.

Radio opaque and non opaque teflon has been used as catheter material as well as the same opaque polythene material as previously described by ÖDMAN (1956). Teflon appears to be ideal for the percutaneous introduction of balloon catheters into relatively small vessels, as it can be made into thin walled tubes of considerable strength. The difficulties of obtaining sufficient radio opacity of these catheters may be overcome by the insertion of flexible steel wire or preferably by the injection of contrast medium into the lumen. The cheap polythene material is quite satisfactory, however, for percutaneous introduction of balloon catheters into large sized vessels. It is strong enough for its purpose and is also easier to mould than teflon. Special latex rubber balloons of a capacity of about 40 ml, and of 80 ml, or over, are used.

The lumen, a short distance distal to the balloon in catheter type I is blocked, and beyond this a side hole is located. This catheter is provided with a small sized balloon.

Catheter type II is tapered down at the site of the balloon so that the balloon and the catheter material occupy no more space than the other parts

advanced through the atrial septal defect and the balloon inflated with 30 ml Urografin 30 % By pulling on the catheter the defect in the atrial septum could be closed for 15 minutes

The coronary arteries in a case of severe angina pectoris is illustrated in Fig 3b Temporary occlusion of the inferior vena cava was also effected with contrast injection through a separate catheter above the aortic root, in connection with coronary angiography A percutaneous balloon catheter type II was introduced into the femoral vein and advanced to the right atrium The balloon was then inflated with 40 ml diluted contrast medium and the inferior vena cava occluded by pulling on the catheter A considerable drop in the systemic blood pressure occurred by reason of the reduction in the venous return to the right side of the heart During the reduced circulation in the aorta 30 ml Urografin 76 % were injected in order to show the coronary vessels The same procedure has been utilized in coronary angiography with a non radiopaque teflon catheter and the injection of physiologic saline solution into the balloon By this method no part of the heart is obscured

Discussion

The utilization of balloon catheters as a method of mechanically changing the circulation has been utilized clinically to a relatively small extent to date The reason has probably been that surgical exposure of the vessels has been necessary before the balloon catheters could be inserted With these new catheters inserted into vessels by the technique described it appears possible that the advantage of balloon occlusion of vessels and intercardiac defects could be practized to a larger extent than previously in physiologic as well as in roentgendiagnostic examinations

SUMMARY

A method of percutaneous insertion of balloon catheters and the construction of five types of such catheters are described

ZUSAMMENFASSUNG

Eine Methode zur percutanen Einfuhrung von aufblasbaren Kathetern und 5 Modelle von solchen Kathetern werden beschrieben

RÉSUMÉ

Description d une méthode d introduction percutanée de cathéters à ballonnet et de la construction de cinq types de ces cathéters



Fig 3 a) Temporary occlusion of an atrial septal defect after percutaneous insertion of a balloon catheter type I b) Percutaneous insertion of a balloon catheter type II through a femoral vein The balloon was inflated with 40 ml contrast medium and the inferior vena cava occluded by pulling on the catheter Injection was made into the ascending aorta through an extra catheter percutaneously inserted into a femoral artery

with a relatively long distance between the tip and the distal side hole With the tip introduced into the vessel, but the distal side hole still not through the skin, the guide wire is removed so that only the catheter and the balloon passes through the puncture hole in the wall of the vessel In the balloon catheter type III the wire may be taken out through the proximal end of the catheter

It is generally necessary slightly to increase the size of the puncture hole in the skin in order to allow the balloon to pass through, and this can be effected with a small pair of scissors The puncture hole may if necessary first be dilated be means of an ordinary, slightly larger, single lumen catheter Fig 2 shows a roentgenogram of a balloon catheter type II, before and after insufflation of 15 ml contrast medium The catheter is locally tapered down to a smaller size at the site of the balloon A steel wire is inserted through the hole at the tip and taken out through the side hole distal to the non inflated balloon The proximal end of the catheter is provided with a Luer connection stopcock

Percutaneous insertion of balloon catheters is illustrated in Fig 3 An atrial septal defect is represented in Fig 3a A balloon catheter type I could be inserted percutaneously into the femoral vein on the right side, in spite of the presence of scar tissues after previous catheterizations The catheter tip was

advanced through the atrial septal defect and the balloon inflated with 30 ml Urografin 30 %. By pulling on the catheter, the defect in the atrial septum could be closed for 15 minutes.

The coronary arteries in a case of severe angina pectoris is illustrated in Fig. 3b. Temporary occlusion of the inferior vena cava was also effected with contrast injection through a separate catheter above the aortic root, in connection with coronary angiography. A percutaneous balloon catheter type II was introduced into the femoral vein and advanced to the right atrium. The balloon was then inflated with 40 ml diluted contrast medium and the inferior vena cava occluded by pulling on the catheter. A considerable drop in the systemic blood pressure occurred by reason of the reduction in the venous return to the right side of the heart. During the reduced circulation in the aorta 30 ml Urografin 76 % were injected in order to show the coronary vessels. The same procedure has been utilized in coronary angiography with a non radiopaque teflon catheter and the injection of physiologic saline solution into the balloon. By this method no part of the heart is obscured.

Discussion

The utilization of balloon catheters as a method of mechanically changing the circulation has been utilized clinically to a relatively small extent to date. The reason has probably been that surgical exposure of the vessels has been necessary before the balloon catheters could be inserted. With these new catheters inserted into vessels by the technique described it appears possible that the advantage of balloon occlusion of vessels and intercardiac defects could be practized to a larger extent than previously in physiologic as well as in roentgendiagnostic examinations.

SUMMARY

A method of percutaneous insertion of balloon catheters and the construction of five types of such catheters are described.

ZUSAMMENFASSUNG

Eine Methode zur percutanen Einfuhrung von aufblasbaren Kathetern und 5 Modelle von solchen Kathetern werden beschrieben.

RÉSUMÉ

Description d'une méthode d'introduction percutanée de cathéters à ballonnet et de la construction de cinq types de ces cathéters.

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ANGIOGRAPHY IN SPONTANEOUSLY HEALED HYPERNEPHROMAS

by

OSBORNE BARTLEY and CARL GUSTAV HELANDER

Marked regression with areas of necrosis and hemorrhage as well as cysts is not uncommon in hypernephromas and has been described by GRAWITZ (1883) ISRAEL (1925) and LJUNGGREN (1930) Both LJUNGGREN and ISRAEL pointed out that in certain cases it may be extremely difficult at operation to distinguish between a solitary renal cyst and a hypernephroma that has undergone cystic transformation There are cases recorded (ALBRECHT 1905 FABRICIUS 1911 ARKIN 1926 MORO 1933, GOLDSTEIN & ABESHOUSE 1938) in which the regressive changes were so conspicuous that the primary tumor appeared to have healed but in several of these cases recurrences or metastases subsequently developed

Spontaneous healing of hypernephromas may nevertheless occur as first reported by HULTQUIST (1944) In 1950 BARTLEY & HULTQUIST collected 26 cases of spontaneously healed hypernephromas All the growths were incidental findings at autopsy and ranged in size from a bean to a cherry they were usually encapsuled and had characteristic macroscopic and microscopic appearances Some of the tumors contained cysts but the morphology was basically uniform The series was subdivided into three groups as regards the presence of tumor cells The tumors in group III had distinct but relatively sparse hypernephroma cells In group II a few hypernephroma like cells with marked regressive changes were manifest while in group I no tumor cells were present

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a b

Fig 1 Case 1 a) Urography Large expansive process at the lower pole of the kidney b) Aortography Hypernephroma Typical pathologic vessels are seen in some places but certain areas of the tumor are avascular (cf fig 2a)

One of the 26 cases was of particular interest in that a total of four small hypernephromas of varying appearances were found Two of the tumors, referable to groups I and III respectively, had healed, the third showed moderate regressive changes, while the fourth presented typical hypernephroma appearances but no regressive changes Since the morphologic pattern was the same in all 26 cases and clearly differed from that of other pathologic conditions as, for instance, post infarction scars, BARTLEY & HULTQUIST assumed that these three groups represented different healing stages of hypernephroma and that the regression could lead to complete disappearance of tumor tissue These observations were corroborated by ZAK (1957)

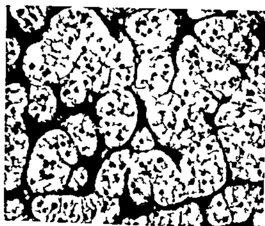
As far as the present authors are aware no report of angiographic examination in cases of spontaneously healed hypernephromas has heretofore been published and consequently feel that the following three cases may be of interest

Case reports

Case 1 Female aged 70 Urography for hematuria ten years previously had revealed a large expansive process at the lower pole of the left kidney (Fig 1a) Aortography was not performed and operation was refused She now returned with hematuria The urographic findings were the same as before



a



b

Fig 2 Case 1 a) Surgical specimen Broad strands of sclerotic connective tissue (arrows) alternating with cysts and viable tumor tissue in the hypernephroma (cf Fig 1b) b) Photomicrograph showing typical hypernephroma tissue

Aortography (Fig 1b) revealed the expansive process to be a hypernephroma containing occasional moderate numbers of typical pathologic vessels with variations in caliber and arteriovenous shunts Certain areas of the tumor were devoid of pathologic vessels and contained less contrast accumulation than the rest of the neoplasm and the adjacent normal renal parenchyma Nephrectomy was performed and the diagnosis was verified by histologic examination (Fig 2b) The poorly vascularized areas consisted both macroscopically and microscopically of markedly regressive changes with broad sclerotic strands of connective tissue (Fig 2a) In certain parts of the tumor appreciable fibroblast proliferation was observed in the immediate vicinity of hypernephroma cells which presented evidence of marked regressive changes

The hematuria persisted after nephrectomy and cystoscopy revealed a bladder carcinoma which at examination before operation had been obscured by blood in the bladder

Case 2 Male aged 73 admitted for prostatic symptoms Urography disclosed an expansive process about 5 cm in diameter in the lateral part of the middle of the right kidney (Fig 3a)

Aortography was carried out in order if possible to determine the nature of the lesion The arterial branches appeared to be stretched in an arc around the expansive process just lateral to which was a structure about 1 cm in diameter supplied by a few small regular arterial branches No pathologic vessels were discernible (Fig 3b)

In the nephrographic phase there was less accumulation of contrast medium in the expanding process than in the surrounding renal parenchyma while in the smaller structure a certain accumulation of medium was detectable The larger tumor was sharply delineated against the renal parenchyma (Fig 3c)

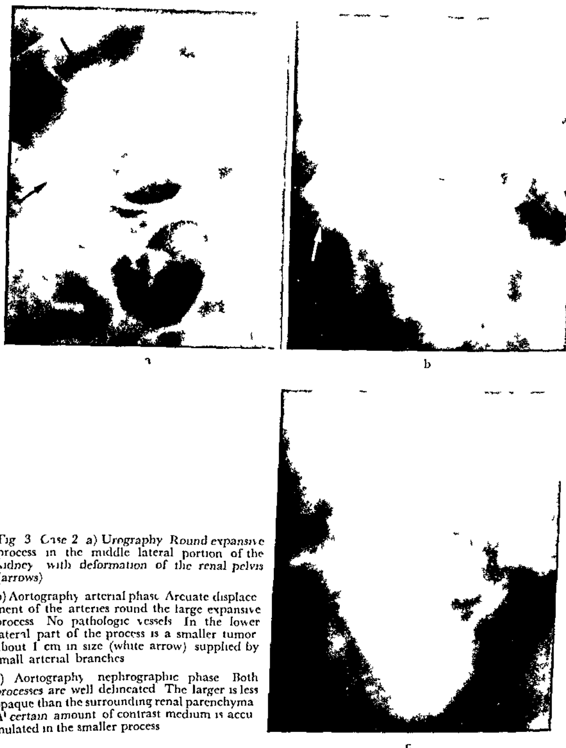


Fig 3 Case 2 a) Urography Round expansive process in the middle lateral portion of the kidney with deformation of the renal pelvis (arrows)

b) Aortography arterial phase Arcuate displacement of the arteries round the large expansive process No pathologic vessels In the lower lateral part of the process is a smaller tumor about 1 cm in size (white arrow) supplied by small arterial branches

c) Aortography nephrographic phase Both processes are well delineated The larger is less opaque than the surrounding renal parenchyma A certain amount of contrast medium is accumulated in the smaller process

Nephrectomy was performed and the large expansive process which proved to be cystic was punctured Contrast medium was injected into the cystic formation which at subsequent roentgen examination presented appearances typical of a renal cyst It was about 5 cm in



Fig 4 Case 2 Operation specimen A capsule varying in thickness from 2 to 5 mm encloses the larger cystic formation The wall is slightly trabeculated Scattered small blood coagula are present A solid tumor about 1 cm in size (arrow) lies in the lower lateral aspect of the larger structure

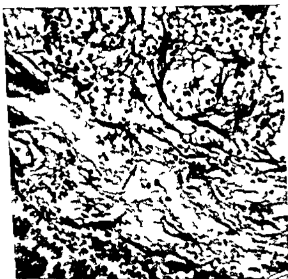


Fig 5 Case 2 Photomicrograph of the large cystic tumor A small area of the cyst contains sparse hypernephroma cells with marked regressive changes (arrow)

size and was enclosed by a capsule the thickness of which varied from 2 to 5 mm (Fig 4) Signs of trabeculae were observed in the cyst but otherwise the wall was smooth parts of the surface were covered with a film of coagulum Three small mostly solid neoplasms were

present on the lateral aspect of the cystic formation The largest of these about 1 cm in size had been disclosed at aortography

Histologic examination revealed that the capsule of the large cyst consisted of cell deficient collagenous connective tissue in which elastic fibrils were irregularly interspersed and that remnants of hypernephroma cells with marked regressive changes were present in a circumscribed area in that part of the cyst directed towards the kidney surface (Fig 5) The small neoplastic formations were composed of highly differentiated hypernephroma cells with varying degrees of regressive changes and were separated from the adjacent renal parenchyma by a thin, capsule like layer of connective tissue

Case 3 Female aged 58 complaining of bladder symptoms At urography an indentation was observed in the mid portion of the right kidney No expansive process was demonstrable and the renal pelvis appeared normal (Fig 6a)

Since the cause of the kidney deformity was obscure aortography was performed The indentation was found to be a small depression in the cortex containing a superficial neoplastic formation about 15 mm in size No pathologic vessels were observed but a slight accumulation of contrast medium was evident (Fig 6 b and c)

In the absence of a definite diagnosis operation was performed Only a cyst filled with clear yellow fluid was found and its wall was excised

Histologic examination revealed that the capsule consisted of collagenous connective tissue rather poor in cells but with numerous somewhat dilated capillaries (Fig 7a) In one or two areas sparse formations of highly differentiated hypernephroma cells generally exhibiting regressive changes were evident (Fig 7b) This finding which was unexpected led to nephrectomy at a second operation On histologic examination of the excised kidney a small remnant of cyst wall was observed to contain a few highly differentiated hypernephroma cells with advanced regressive changes

Discussion

Common to the renal tumors in these three cases were the marked regressive changes In Cases 2 and 3 the neoplastic tissue had virtually disappeared and the growths had undergone cystic transformation Indeed, in the last mentioned case the lesion could not be differentiated at operation from an ordinary cyst, and only the demonstration of very sparse hypernephroma cells with marked regressive changes in the cyst wall served to establish the diagnosis The neoplasm in this case was morphologically identical to the spontaneously healed group III hypernephromas described in the introduction The second hypernephroma which had undergone cystic changes (Case 2) presented much the same picture, though it contained, in addition, sparse, probably viable tumor tissue consisting of a few small nodules on its free surface It would appear to the writers that these two cases represent different stages of healing of hypernephroma The hypernephroma with pathologic vessels (Case 1) also displayed signs of scattered healing, but since it contained an abundance of viable tumor tissue it could not be regarded as healed In view of the histologic findings and the remarkable clinical course in Case 1, the question arises, however, whether all three cases do not in fact represent different stages of spontaneous healing

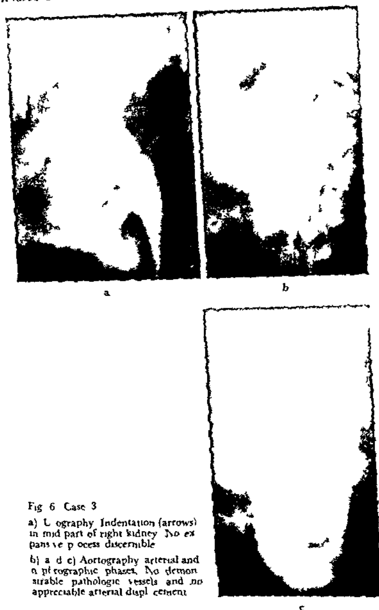


Fig 6 Case 3

a) Urography. Indentation (arrows) in mid part of right kidney. No expansive process discernible.

b) and c) Aortography, arterial and nephrographic phases. No demonstrable pathologic vessels and no appreciable arterial displacement.

Hypernephromas usually contain neoplastic blood vessels. BILLING & LINDGREN (1944) studied the roentgenologic appearance after injecting contrast medium into the large vessels of excised hypernephromas and LINDGREN (1945) described the histology of the tumor vessels. The pathologic vessels are characterized primarily by their greatly varying caliber and by the fact

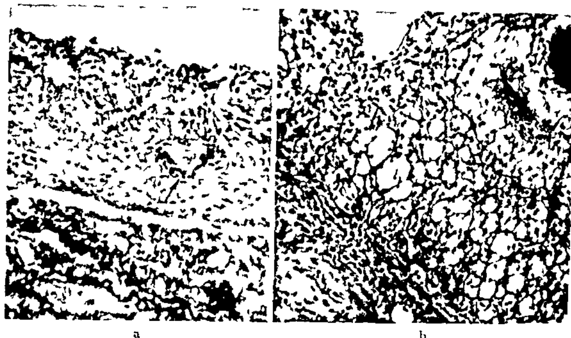


Fig. 7. Case 3. Photomicrographs. a) Tumor capsule. Collagenous connective tissue with paucity of cells but numerous somewhat dilated capillaries (arrows). b) Renal tumor. Areas of highly differentiated hypernephroma cells with marked regressive changes.

that they constitute arteriovenous shunts. LINDGREN observed no vessels in the necrotic portions of the tumors but numerous capillaries, many of them dilated, in the viable parts. The presence of pathologic vessels in hypernephromas is generally considered tantamount to malignancy. It is therefore remarkable that the hypernephroma in our Case 1 did not present clinical signs of malignancy even though it had been present, to all appearances, for at least ten years.

Angiographic aspects of hypernephroma have been studied notably by FOSMAN (1958). Most of the malignant renal tumors in his series, totalling 80 cases, were hypernephromas. Only five of these cases had neither pathologic vessels nor contrast accumulation in the tumor. In four of these five the angiographic findings nevertheless sufficed for differentiation of the process from a cyst. The fifth case was a necrotic hypernephroma with metastases.

Although hypernephromas as a rule contain pathologic vessels, it is a well known fact that the vascularity may vary. The factors underlying this variability are not altogether clear. Paucity of blood vessels in a hypernephroma, or in parts of such a growth, is probably attributable in most cases to areas of necrosis and hemorrhage, and occasionally, as in our cases, to *healing* processes in the tumor.

It is notably the presence of typical pathologic blood vessels that makes possible the angiographic *diagnosis of hypernephroma*. Such vessels served to

establish the diagnosis in Case 1 but were not demonstrable in the other two cases In cases of solid tumors devoid of pathologic vessels, the angiographic diagnosis presents far greater difficulties A malignant solid tumor may never theless be distinguished as EDSMAN pointed out by virtue of its diffuse border with the surrounding renal parenchyma A sharply delineated, poorly vascularized expansive process on the other hand, is usually indistinguishable angiographically from a renal cyst renal puncture may then well differentiate between a solid and cystic tumor

A renal cyst has the angiographic appearances of a poorly vascularized well defined expansive process with no accumulation of contrast medium the thin cystic wall being largely devoid of capillaries A hypernephroma with regressive changes is in contrast to a renal cyst enclosed in a comparatively thick capsule with a fairly abundant capillary supply which permits the accumulation of contrast medium within the tumor

In Cases 2 and 3 the specific diagnosis of hypernephroma was scarcely possible since typical tumor vessels were absent Due to a certain degree of opacification both lesions were angiographically distinguishable from common renal cysts In Case 2 the medium was taken up by a small, largely solid tumor nodule whereas the main, cystic part of the neoplasm was not appreciably filled The last mentioned portion was on the whole, sharply defined in relation to the surrounding renal parenchyma and in the absence of the solid tumor nodule would hardly have been distinguishable from a solitary renal cyst or a poorly vascularized solid growth If renal puncture instead of angiography had been performed in this case the process might well have been misdiagnosed as a common renal cyst The accumulation of contrast medium in Case 3 was probably due to capillaries in the tumor capsule rather than to capillaries in the sparse tumor vegetations In each of these two cases the contrast accumulation was much less conspicuous in the lesions than in the surrounding renal parenchyma and could be detected only when part of the neoplasm was demonstrated separately from the kidney

If a definite roentgenologic diagnosis of spontaneously healed hypernephromas were possible nephrectomy could perhaps be avoided in such cases LJUNGGREN (1960) commenting on one of our cases in which nephrectomy was performed questioned whether kidney resection would not have been adequate We feel however, that so far our own experience does not permit us to venture an opinion as to whether an exact roentgenologic diagnosis is possible

SUMMARY

Three cases of spontaneously healed hypernephroma that were examined by angiography are reported The regressive changes are described and the differential diagnosis between such changes and those due to a renal cyst are discussed The question of the possibility of a definite roentgenologic diagnosis of spontaneous healing in hypernephroma is considered

ZUSAMMENFASSUNG

Drei Falle von Spontanheilung von Hypernephromen wurden angiographisch un Die regressiven Veranderungen werden beschrieben und die Differentialdiagnose Nierencyste und heilendem Hypernephrom besprochen Die Moglichkeit der Di stellung von geheiltem Hypernephrom wird erortert

RÉSUMÉ

Trois cas d hypernéphrome guéris spontanément ont été examinés par angiograp auteurs décrivent les modifications régressives et discutent le diagnostic différentiel modifications et celles dues à un kyste rénal Ils étudient la possibilité de faire un di *radiologique certain de guérison spontanée de l hypernéphrome*

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COMPLICATIONS IN LYMPHOGRAPHY WITH OILY CONTRAST MEDIA

by

W A FUCHS

Oily contrast media have recently come into widespread use for lymphography Initial reports by BRUUN & ENGESET (1956) PROKOPEC & KOLIHOVA (1958 1961) ZHEUTLIN & SHANBROM (1958) SHEEHAN et coll (1961) and WALLACE et coll (1961) have been followed by papers by JACKSON et coll (1961) PICARD & ARVAY (1961) BOBBIO et coll (1961), RUTTIMANN et coll (1961 ARNULF & BOLEY (1961) MARCHAL et coll (1961) MOULONGUET DOLERIS et coll (1961) JOMAIN & PICARD (1961) VIAMONTE et coll (1962) SCHAFFER et coll (1962) and FISCHER et coll (1962) All these authors report only infrequent and minor complications Apart from slight lipogranulomatous reactions in the lymph nodes they mention the possibility of fine pulmonary embolization due to the contrast medium entering the venous circulation We were at first reluctant considering these risks to inject oily contrast media in to the lymphatic system (FUCHS & BOOK HEDERSTROM 1961) However having regard to the favourable reports published we began to perform lymphography with an oily contrast medium Four cases of complications in a series of 20 mainly bilateral investigations then made us cautious in the use of the procedure The purpose of this paper is to report and discuss these incidents

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Fig 1 Case 4 Lymphogram immediately after bilateral injection of 25 ml Lipiodol Ultrafluid The lymphatic system is filled as high as the cisterna chyli

Case reports

Case 1 Female aged 52 with carcinoma of the uterine cervix Ten and 12 ml Lipiodol Ultrafluid were injected at the rate of 0 3 ml/min into a subcutaneous medial lymphatic on the dorsum of the right and left foot

Roentgenograms taken immediately following the injection demonstrated that the lymphatic system was filled as far as the lower lumbar region Two hours later the patient suddenly collapsed with loss of consciousness and profuse sweating She recovered without special treatment after a few minutes

Case 2 Female aged 63, with carcinoma of the uterine cervix Nine and 14 ml Lipiodol Ultrafluid were injected at the rate of 0 3 ml/min into a subcutaneous medial lymphatic on the dorsum of each foot



Fig 2 Case 4 Roentgen examination of the chest 5 days after lymphography Massive bronchopneumonic consolidation in the peripheral and perihilar parts of both lungs no pleural effusion

Roentgenograms taken immediately after the injection showed filling of the lymphatic system to the region of L4 Collapse of the patient occurred after 3 hours Recovery was rapid and complete Roentgen examination of the lungs the following day revealed no changes

Case 3 Female aged 50 with carcinoma of the uterine cervix Lymphography by injection of 10 and 12 ml Lipiodol Ultrafluid at 0 3 ml/min into the subcutaneous medial lymphatics on the dorsum of each foot

Roentgenograms taken immediately after the injection demonstrated contrast filling of the lymphatics up the upper lumbar region and roentgenograms 24 hours later revealed contrast filled normal lymph nodes in the lumbar and upper mediastinal regions On the 11th day after lymphography the patient had sudden hemoptysis slight chest pain and dyspnea The temperature was normal Roentgen examination of the lungs revealed no parenchymatous changes The general condition of the patient was not impaired and the chest symptoms abated without special treatment

Case 4 Female aged 32 with carcinoma of the uterine cervix Eleven and 14 ml Lipiodol Ultrafluid were injected at the rate of 0 3 ml/min into the subcutaneous medial group of lymphatics on the dorsum of each foot and the lymphatic system was filled to the level of the cisterna chyli (Fig 1) The patient immediately began to perspire profusely and became breathless with a rapid pulse and chest pain The signs increased and she coughed up blood

On the second day after lymphography roentgen examination disclosed slight parenchymatous changes in the periphery of the left lung and the iliac and lumbar lymph nodes up

to the region of L 1 as well as some small supraclavicular lymph nodes on the left side were filled with contrast medium. Temperature 38.2° C, WBC 7 100/mm³ (90 % neutrophiles, 9 % lymphocytes), no eosinophilia. SR increased from 15 mm to 55 mm WG. The condition persisted unchanged for the next 5 days but with a slight decrease in the temperature.

Roentgen examination of the chest on the 5th day after lymphography disclosed massive bronchopneumonic consolidation of the peripheral and perihilar regions of both lungs but no pleural effusion (Fig. 2). On the 7th day after lymphography the patient slowly began to improve and the temperature fell. WBC 5 400/mm³ with relative lymphocytosis (37 %) but no eosinophilia. The general condition of the patient had further improved on the 12th day and the temperature was normal. She still had retrosternal pain, increasing with deep inspiration, and difficulty in coughing up mucus. No specific treatment was given during the whole period of illness. One month later the patient was in good physical condition but was still complaining of sternal and left chest pain and, in addition, a swollen throat. WBC 3 600/mm³ with relative lymphocytosis (16 %) but no eosinophilia. SR normal. The lungs on roentgen examination were normal.

Discussion

One severe and 3 minor complications were encountered in a series of 20 mainly bilateral lymphographies with oily contrast media. Two of the cases developed cardiovascular collapse and 2 cases had pulmonary infarction. The clinical picture of these incidents is similar to that encountered in complications in the intravenous injection of oily contrast media in hepato-lienography (OLSSON 1941), or accidentally in myelography (STEINBACH & HILL 1951, GINSBURG & SKORNEK 1955, TODD & GARDNER 1957).

Lipiodol is dispersed into droplets of varying size in the thoracic duct according to cinematographic experimental investigations in dogs by MALEK et coll. (1961). The continuous lymphatic circulation leads to the collection of a large drop of oily material at the superior aspect of the thoracic duct. This aggregation enters the venous circulation at the moment of maximal inspiration and, according to their size, drops of oil are trapped in the lung capillaries and may result in pulmonary infarction.

Laboratory investigations in vitro showed that Lipiodol Ultrafluid does not lead to red cell aggregation (BARANDUN 1962). Pulmonary infarction is therefore most probably due to mechanical obstruction of the lung capillaries by oil droplets and not to impaired blood flow caused by red cell aggregation. The latter is thought to be the primary reason for the clinical signs ascribed to posttraumatic fat embolism (BERGENTZ 1961). Cardiovascular collapse, which occurred in two of the cases, may be caused by minute emboli produced by the oily contrast medium.

The injection speed in lymphography with oily contrast media would not seem to be an important factor in the cause of pulmonary embolism, as suggested by several authors, because pulmonary infarction occurred in our two cases some days after lymphography, by that time the injection pressure has ceased to have any effect upon the lymphatic circulation.

It is however possible that because of a too rapid injection speed the oily contrast medium will directly pass from the afferent to the efferent lymphatics of many lymph nodes and will not be retained in the parenchyma of the nodes The actual amount of contrast medium entering the thoracic duct and the venous circulation is consequently increased under such conditions The use of oily contrast media for antegrade demonstration of the thoracic duct cannot therefore be recommended The large amount of contrast medium needed considerably increases the risk of pulmonary infarction

None of the above complications have ever occurred in the author s personal experience of over 200 lymphographies with water soluble contrast media The injection of oily contrast media for lymphography must be performed only under very strict conditions of control Oily contrast media are necessary for the investigation of the retroperitoneal lymph nodes but the indirect method of cavography gives very valuable information about enlarged retroperitoneal lymph nodes on the right side of the abdominal aorta Even large left sided retroperitoneal tumours may be demonstrated by this method With due consideration of the risks involved lymphography with an oily contrast medium is especially indicated in cases of negative cavography The total amount of oily contrast medium injected on each side should never exceed 10 ml It then spreads over a large number of lymph nodes and can be largely retained through phagocytosis The risk of complications may therefore be diminished The unilateral injection of contrast medium may even in some cases produce filling of the retroperitoneal lymph nodes on the contralateral side

Lymphography with oily contrast media should be performed with great caution and only with a minimal amount of the agent until stable, non toxic and non aggregating colloidal contrast media of acceptable particle size and properties similar to chylomicra are available It must always be realized that the intralymphatic introduction of oily contrast media is a prolonged intravenous injection with all its attendant risks

SUMMARY

Complications in lymphography with oily contrast media are described and discussed The risks consist in pulmonary infarction and cardiovascular collapse due to emboli of the oily material

ZUSAMMENFASSUNG

Die Komplikationen der Lymphographie mit oligen Kontrastmitteln werden erortert Es besteht die Gefahr von Lungeninfarkten und kardiovaskularem Kollaps hervorgerufen durch Embolien des Ölkontrastmittels

RÉSUMÉ

L auteur décrit et étudie les complications de la lymphographie par moyens de contraste huileux Ses dangers sont l infarctus pulmonaire et le collapsus vasculaire dus aux embolies de la substance huileuse

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RENAL ARTERIOVENOUS FISTULAE

by

ERIK BOIJSEN and ROLF KOHLER

An arteriovenous fistula rarely occurs in the kidney The first to describe such a lesion was VARELA (1928), the diagnosis in his case which was verified at necropsy was based on a bruit over the kidney During the next two decades only three cases were reported (RIEDER 1942, PEARSE & MACMILLAN 1947) one of which was secondary to nephrectomy (HOLLINGSWORTH 1934) In the last 10 years 18 cases of an arteriovenous fistula between the renal artery or its branches and the renal vein have been published 6 of them including 4 diagnosed angiographically (SCHWARTZ et coll 1955 MULLER & GOODWIN 1956 POUTASSE 1957 ELLIOT 1961) were secondary to nephrectomy Of the remaining 12 cases 7 were diagnosed angiographically (SCHULZE BERGMANN 1954 KIRBY et coll 1955 SLOMINSKI LAWS et coll 1956 LJUNGGREN & EDSMAN 1956 BOHNE & HENDERSON 1957 JOUVE et coll 1958 SAUTER & SARGENT 1960)

A renal arteriovenous fistula impairs the renal circulation which sometimes causes renal hypertension (RIEDER PEARSE & MACMILLAN, MILLON et coll 1958) In addition the secondary effect on the circulation may lead to cardiac failure (VARELA RIEDER PELOT et coll 1954 BOHNE & HENDERSON JOUVE et coll)

An arteriovenous fistula may be due to a malformation but may also be acquired The arteriovenous connections due to malformation are often multiple of small calibre and may exist for several years without producing any symptoms This may be explained by the slowness of the growth of the

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Fig. 1. Case 1. Arteriovenous malformation. Selective right renal angiography. The renal artery and its branches are slightly narrowed by reduction of parenchyma secondary to pyelonephritis. Several wide tortuous vessels empty directly into the renal vein. Supplementary artery to lower pole is missing due to the selective study.

originally very small connections, the malformation may thus vary from a fairly small haemangioma-like lesion, often called cirsoid aneurysm, to localized fistulation between arteries and veins. Pathologically these malformations are of uniform character (ADAMS 1951, SCHULZE-BERGMAN, MILLOY et coll.). Only 3 definite cases of arteriovenous malformations in the kidney have been described (SCHULZE-BERGMAN, SLOMINSKI-LAWS et coll., LJUNGGREN & EDSMAN).

Three types of acquired arteriovenous fistula may be distinguished.

1. *Fistulae following rupture of an arterial aneurysm.* Of the 15 cases of arteriovenous renal fistulae on record (excluding 7 cases secondary to nephrectomy), 7 were apparently due to rupture of an arterial aneurysm. In one of these cases, however, it is doubtful whether the lesion observed was a true arteriovenous fistula (SAUTER & SARGENT), for though angiography as well as operation showed that a large arterial aneurysm had ruptured, no venous shunt could be demonstrated.

2. *Traumatic arteriovenous fistulae.* Penetrating trauma (2 cases: PELOT et coll., MILLOY et coll.), subcutaneous trauma (2 cases: BARON & KOFNEMANN 1955, KIRBY et coll.) as well as trauma of renal tissue in association with nephrolithotomy (VEST 1954, 1 case) may cause arteriovenous shunts. Fistulae secondary to nephrectomy may also be assigned to this group (7 of 22 cases).

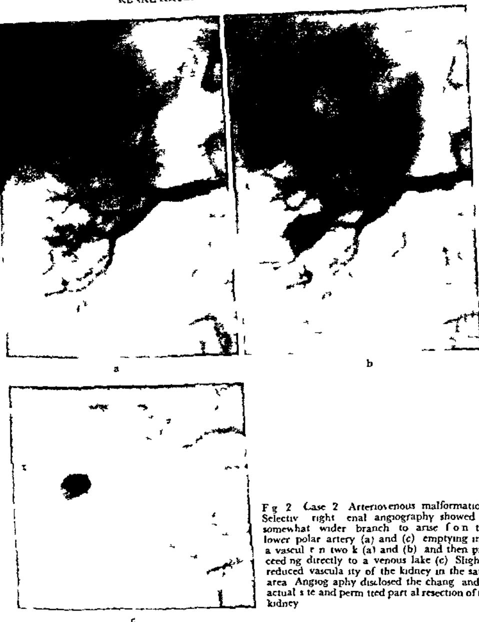


Fig 2 Case 2 Arteriovenous malformation Selective right renal angiography showed a somewhat wider branch to arise from the lower polar artery (a) and (c) emptying into a vascular rn two k (a) and (b) and then proceeding directly to a venous lake (c) Slightly reduced vascularity of the kidney in the same area Angiography disclosed the change and its actual site and permitted partial resection of the kidney

3 *Arteriovenous fistulae in renal carcinoma* Most collections of arteriovenous fistulae in the kidney include 2 cases of renal carcinoma (HAMILTON et coll 1953 MYHRE 1956) in which the tumor had eroded the vein Arteriovenous shunting in renal cancer is common (EDSMAN 1958 BOIJSEN & FOLIN 1961)



Fig. 3. Case 2. Angiography of operation specimen.

though such a shunt may be considered in the establishment of an angiographic differential diagnosis, it should not be classified under the heading of arteriovenous fistula.

While arteriovenous fistulae in the kidney were formerly diagnosed by auscultation or surgical exploration, they can now be detected by renal angiography. This examination method, which has gained an established place and is now widely used for a large range of indications, must be credited for the marked increase in the number of cases diagnosed during the last decade. Despite this increase, arteriovenous fistula in the kidney is still regarded as a rare condition and so far no author has reported more than one personal case. During the last 3 years we have seen 5 cases of arteriovenous fistula, 4 of which were diagnosed by renal angiography. These cases are described below to illustrate the angiographic appearances of the condition, and to show that if the range of indications for renal angiography is widened, or if this examination method is used in all cases of so called essential haematuria, it will probably be found that the condition is not quite so rare as is widely supposed. In addition, renal angiography will show not only the presence of a fistula but also locate it exactly, it will demonstrate the tributaries as well and thereby help in the assessment of the operability of a given case and facilitate the planning of the operation.

Case reports

Case 1 (Fig. 1). A woman of 29 in the 4th month of pregnancy had had a short attack of gross haematuria and pain in the right flank. Blood pressure was normal (120/80 mm Hg) and there was no evidence of cardiac failure.



Fig 4 Case 3 Arteriovenous fistula secondary to percutaneous renal biopsy Preoperative selective right renal angiography Markedly widened renal and lower polar arteries supplying a fistula in the lower renal pole The medium passes via small veins directly into the inferior caval vein The vascularity of the lower pole is slightly reduced

At *urography* a slight impairment of the function of the right kidney was found but otherwise nothing of interest Four months later haematuria recurred this time with a raised temperature Therapeutic abortion was induced and at urography a few weeks later impaired function of the right kidney and small changes in the renal papillae were demonstrated The right kidney was also smaller than the left

At *renal angiography* there was evidence of pyelonephritis as well as an area 25 mm by 15 mm in the posterior part of the renal hilum with numerous wide arteries branching from the dorsal artery These arteries communicated directly with wide veins and contrast medium passed into the vein in this part of the kidney much quicker than in the remainder Apart from the reduction due to the chronic pyelonephritis the vascularity of the kidney was normal The arterial branches supplying the shunt were not widened In view of the rapidly progressing pyelonephritis and the arteriovenous malformation the right kidney was removed

Pathologic examination Chronic pyelonephritis and interstitial nephritis Wide tortuous arteries and veins beneath the mucosa of the renal pelvis

Case 2 A woman of 30 had had repeated evidence of cystitis for 12 years and during the previous 3 weeks signs of cystitis and haematuria She then had a sudden attack of pain in the right flank precipitant micturition and passed blood stained urine containing coagula The blood pressure was normal (120/80 mm Hg) and there was no evidence of cardiac failure

Urography was performed during the attack and it was found that the right kidney was of normal size but functionless

At *cystoscopy* the bladder was markedly distended by coagula after the removal of which blood was seen to flow from the right ureter

At *pyelography* the lower calyx was found to be occluded

Right sided *selective renal angiography* (Fig 2) was performed and an anterior branch of the renal artery running to the lower pole was found to give off widened tortuous branches covering an area of 30 mm by 18 mm and empty into a markedly widened vein this vein



Fig 3 Case 2 Angiography of operation specimen

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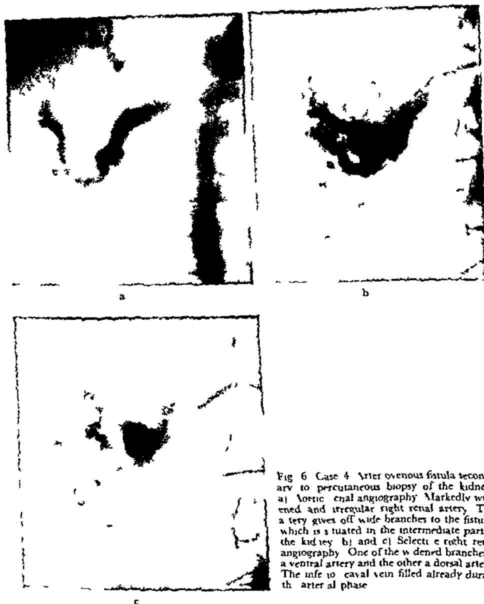


Fig 6 Case 4 Arter ovenous fistula second ary to percutaneous biopsy of the kidney a) Aortic enal angiography Markedly wid ened and irregular right renal artery The a tery gives off wide branches to the fistula which is s tuated in the intermediate part of the kid ıey b) and c) Selecti e right renal angiography One of the w dened branches is a ventral artery and the other a dorsal artery The infe io caval vein filled already during th arter al phase

At *urography* two years later when the patient was admitted because of hypertension a small poorly functioning left kidney was found

Sele tive renal angiography on that occasion disclosed *marked reduction* of the parenchyma and of the vascularity of the upper and middle parts of the left kidney

Conventional treatment failed to control progression of the heart condition and the patient was readmitt d The blood pressure was now almost normal (150/90 mm Hg)



Fig 5 Case 3 Postoperative selective right renal angiography Lower polar artery and lower renal pole resected Normal vascularization of remaining part of kidney

appeared earlier and was more distinctly outlined than the other renal veins The vascularity of the lower renal pole was slightly reduced In view of these findings i e typical features of an intrarenal arteriovenous fistula the lower pole of the kidney was resected (Fig 3) The postoperative course was smooth and at control urography the remaining part of the right kidney was functioning satisfactorily

Case 3 A man of 41 had had proteinuria in association with scarlet fever in childhood and on a second occasion when he was 20 years of age When he was 39 he had left sided haemiparesis and examination on that occasion revealed arterial hypertension (275/140 mm Hg)

He was treated conservatively and one year later urography was performed without any evidence of changes Percutaneous biopsy of the right kidney at that time showed benign nephrosclerosis this procedure was not followed by any immediate complications and conservative treatment was continued

At *control urography* one year later it was found that the right kidney had somewhat decreased in size and that the outline of the lower pole was irregular the outline of the pelvis was normal

Selective renal angiography was performed in view of the urographic findings The right renal artery and its lower polar branch were markedly widened and contrast medium passed from the latter directly into the lower polar vein and then into the inferior caval vein before it entered the other renal veins (Fig 4) Contractions in the lower pole of the kidney due to scarring and reduced vascularity were evident The wide lower polar artery was ligated and the lower pole resected

Pathologic examination revealed marked nephrosclerosis with advanced changes of the wall of the lower polar artery Six months after resection the general condition of the patient was improved but the blood pressure was still above normal Further selective angiography of the right kidney showed that the vascular pattern of the remaining part of the kidney was normal (Fig 5)

Case 4 A woman of 57 who had been treated 3 years previously for struma and diffuse pain under the right costal arch as well as hypertension (190/130 mm Hg) with moderate heart symptoms Examination at that time had included right sided renal biopsy by percutaneous needle puncture Histologic examination has shown normal renal tissue but slight nephrosclerosis



Fig 8 Case 5 Arteriovenous fistula secondary to nephrolithotomy Angiography of operation specimen Branch of dorsal artery supplying a lower intermediate part of the kidney is wide and tortuous Sparse filling of vein draining fistula

tomy was performed and marked pulsations were evident in a limited region medial to the upper part of the renal hilum

Angiography of the operation specimen (Fig 8) disclosed an arteriovenous aneurysm with a severely dilated and markedly irregular dorsal artery

Discussion

The comparatively large number of arteriovenous fistulae observed by the writers cannot be ascribed to chance but rather to the use of renal angiography for a wide range of indications including in particular, different forms of obscure haematuria in which the cause is sought in changes in the renal vessels The fact that the renal angiographies were performed selectively must also have been of importance

Three of our cases had gross haematuria and at angiography an arteriovenous fistula was found in both cases examined by this method In the third case the diagnosis could also have been established by angiography which was however withheld owing to haemophilia

Two of the 5 cases of arteriovenous fistula were classified as malformations because they both occurred in young subjects there was no history of trauma, and the angiographic appearances differed from those in the other 3 cases with known old penetrating injuries

In the two cases of arteriovenous malformation the arterial branch supplying the fistula was at angiography found to be of normal or slightly in



Fig 7 Case 4 Selective angiography of the right kidney 2 months after operation An avascular area in the intermediate part of the kidney is evident but no fistula

At *renal angiography* (Fig 6a) this time with injection of the contrast medium into the aorta it was found that except in its most proximal part the right renal artery was abnormally wide

With the aid of *selective angiography* of the right kidney (Fig 6 b and c) it was possible to show that two arterial branches — one from the ventral artery and one from the dorsal artery — supplying the upper intermediate part of the kidney were severely widened and contrast medium flowed through them directly into the renal vein In this area the parenchyma was less vascularized and the outline of the kidney was contracted indicating parenchymal destruction The poor renal function on the left side contraindicated removal of the right kidney

At operation the two wide arterial branches were readily identified and ligated after which the palpable thrill disappeared

Selective right renal angiography was performed two months after the operation The upper and lower renal poles presented normal vascularization while the intermediate part of the kidney had no blood supply The passage of the contrast medium through the remaining functioning parts of the right kidney was normal (Fig 7) The blood pressure 2 months after operation was still elevated (180/105 mm Hg)

Case 5 A man of 55 who had long been known to have haemophilia and who for 3 years had had right sided nephrolithiasis and hypertension (235/120 mm Hg) The stone on the right side was situated in the pelviureteric junction and had caused considerable stasis and dilatation with pain and signs of infection Despite the haemophilia it was decided to operate Not until after several unsuccessful attempts was it possible to remove the stone The operation was immediately followed by haematuria which could not be controlled

Cystoscopy revealed that blood came in gushes from the right ureter

At *urography* a few months after operation — the patient was still bleeding — no contrast medium was found to be excreted on the right side Despite the risks of re operation nephrec

branch or branches running to the fistula were markedly widened with considerable mural irregularities, the caliber of the artery was almost uniform until it reached the fistula In the two cases examined angiographically contrast medium passed to the renal vein, and the inferior caval vein in the early arterial phase but contrary to that evident in the arteriovenous malformations no widened small vessels were demonstrable between the larger arterial branch and the vein The parenchyma peripheral to the fistula was less well vascularized than the rest of the kidney, which was apparent from contractions of the outline of the kidney in the nephrographic phase

It is not possible to demonstrate any characteristics of arteriovenous fistula by conventional roentgen examination of the urinary tract and urography In shunts secondary to arterial aneurysm however, calcifications may be seen at the site of the aneurysm (BOHNE & HENDERSON, JOUVE et coll) In none of our five cases were such calcifications observed On the other hand, in three of the cases conventional roentgenography of the kidneys disclosed contractions of the renal surface at the site of the aneurysm In Case 3 these scars or contractions had occurred after needle biopsy

The urographic appearance varies from that of a nonfunctioning kidney to irregular filling of the pelvis and calyces due to coagulum or fistula, in the latter case the possibility of the presence of a tumor must be considered Arteriovenous fistula and renal carcinoma may be differentiated by angiography though shunts are common in the latter In the two cases of arteriovenous malformation (Cases 1 and 2) the angiographic appearances were partly similar to those in renal carcinoma Thus in an arteriovenous malformation as well as in a renal carcinoma shunting of blood to the renal vein as well as wide tortuous vessels in a localized area of the kidney may be evident The arteriovenous malformations however do not have the irregular pathologic vessels seen in a renal tumor and no displacement of the vessels or other signs of an expanding process are evident

In view of the reduced vascularization of the kidney in arteriovenous fistula the possibility of hypertension produced by renal ischemia has been considered Cases have also been described with regression of hypertension after nephrectomy (RIEDER PEARSE & MACMILLAN BARON & KOENEMANN GARRITANO 1957) The blood pressure was normal in the two ca es of our series with arteriovenous malformation although in one of them (Case 2) the vascularity of the renal parenchyma close to the malformation was slightly reduced The three cases with traumatic arteriovenous fistulae had hypertension which however had been present before the trauma and which, in one of the cases diminished after the shunt had been established (Case 4) This latter case was also the only one with signs of increasing cardiac failure after the occurrence of the fistula and this may explain the regression of the hypertension (RIEDER)

creased width. Contrast medium passed from this branch into widened tortuous vessels, and a filling was obtained of the veins already during the arterial phase.

Case 1 represents an early stage of an arteriovenous malformation known as cirsoid aneurysm. The haematuria was probably due to pyelonephritic changes with papillary necrosis, and the finding of the arteriovenous malformation was purely accidental. If this fistula had been allowed to persist, it would probably have become enlarged by the arterial pressure directly transmitted to the veins and sooner or later have ruptured into the renal pelvis, as in Case 2, in which locally widened branches entered directly into a large venous lake. The latter case had massive haematuria requiring immediate operation. It was found at retrograde pyelography that the lower renal calyces were filled probably by a blood clot. Renal angiography gave detailed information which limited the operation to resection of the lower pole. Without angiography it would not have been possible to save any part of the kidney.

Although acquired arteriovenous fistula are most commonly due to ruptured arterial aneurysms, none of our cases could be assigned to this group as in all three cases penetrating trauma to the renal parenchyma was known to have been sustained and *the shunts were localized to the peripheral parts of the parenchyma.*

It is interesting to note that percutaneous needle biopsy of the kidney *appears to have been the causal factor in two of the cases. This procedure* is now almost a routine measure in certain clinics. Reviews of complications of needle biopsy have shown that haematuria is the most common complication (IVERSEN & BRUN 1951, KARK & MUEHRCKE 1954, MUEHRCKE, KARK & PIRANI 1955) but the possibility of it causing intrarenal arteriovenous fistulation seems to have escaped attention. In our 2 cases, histologic examination of the biopsy specimen showed *nephrosclerosis only, this condition had evidently* decreased the elasticity of the vessels and thereby their capacity to close after the blind puncture of the kidney, and this together with arterial hypertension was probably *sufficient to produce a permanent shunt in the kidney.*

In the third case the arteriovenous fistula may be ascribed to repeated scooping of the renal pelvis as well as to the general condition (haemophilia, nephrosclerosis, and hypertension). *Only one case of arteriovenous fistula* secondary to nephrolithotomy has hitherto been described (VEST), namely in a 3 year old girl.

Angiographically, the three *traumatic arteriovenous fistulae differed* considerably from those in cases of arteriovenous malformations. Only in two of the traumatic cases was angiography performed in vivo. In the third case angiography was withheld *because of the haemophilia. Angiography* of the kidney after it had been removed, however, showed appearances coinciding with those of the other two cases examined. The renal artery as well as the

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SUMMARY

Five cases of arteriovenous fistulae in the kidney are described, a number which is remarkably high compared with that reported in the literature (15) due perhaps to the fact that renal angiography has been used at the department for a wide range of indications The angiographic characteristics and the possibilities of distinguishing arteriovenous malformations from acquired arteriovenous fistulae are described Of the three arteriovenous fistulae due to trauma two were caused by percutaneous needle biopsy and one occurred secondary to nephrolithotomy

ZUSAMMENFASSUNG

Funf Fälle von av Fisteln der Niere werden beschrieben eine auffallend hohe Anzahl, verglichen mit den in der Literatur berichteten Fällen (15) Dies hangt wahrscheinlich mit dem Umstand zusammen dass die Indikationsstellung *zur renalen Angiographie an der* Abteilung sehr umfassend war Die angiographischen Charakteristika und die Differentialdiagnose zwischen av Missbildungen und erworbenen av Fisteln werden beschrieben Von den drei posttraumatischen av Fisteln traten zwei nach perkutaner Nadelbiopsie und eine im Anschluss an Nephrolithotomie auf

RÉSUMÉ

Les auteurs présentent cinq cas de fistules artério veineuses du rein nombre particulièrement *élevé en comparaison de celui des cas publiés dans la littérature (15 cas) ceci est peut être* du au fait que l angiographie rénale a été pratiquée dans leur service avec des indications assez larges Ils décrivent les caractéristiques angiographiques et les possibilités de distinguer les malformations artério veineuses des fistules artério veineuses acquises Sur les trois fistules artério veineuses d origine traumatique deux étaient dues à une biopsie percutanée à l aiguille et une apparut secondairement à une néphrolithotomie

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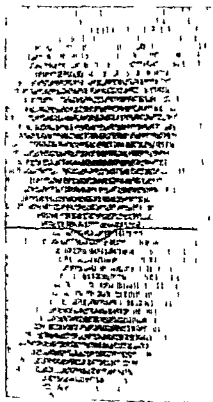


Fig 1 Scintillogram in a case of intrathoracic goiter Uniform collection of radioiodine in right lobe nodule and intrathoracic tissue (24 hour uptake = 45)



Fig 2 Scintillogram in a case of persistent intrathoracic goiter following subtotal strumectomy Remnants of thyroid tissue in the neck as well as in intrathoracic goiter (24 hour uptake = 35)

An occult intrathoracic goiter was found in two of 150 cases in which scintillograms were obtained The goiter had not previously been detected nor were there any symptoms or signs in either of these cases

Case reports

Case 1 Female aged 44 with nodular goiter in the neck As may be seen from the scintillogram (Fig 1) iodine is accumulated uniformly in the thyroid tissue and in the nodule in the right lobe Thyroid tissue oval in shape and 50 mm in diameter was evident behind the sternum equal in amount to that of the thyroid gland it was not connected with the thyroid in the neck Further roentgen examination disclosed lying anteriorly in the superior mediastinum an irregular oval mass about 90 × 70 mm in size which transmitted pulsations and moved slightly on coughing

FROM OSRODEK RADIOIZOTOPOWY, SZPITAL BIELANSKI, WARSZAWA, POLAND

OCCULT INTRATHORACIC GOITER DIAGNOSED BY SCINTILLOGRAPHY

by

F GOROWSKI, O CHOMICKI and J ZALUSKA

The diagnosis of an intrathoracic goiter presents some difficulties Goiters of large size causing compression will be found by clinical examination, but reliance upon the detection of small intrathoracic goiters must ordinarily rest upon a roentgenologic examination This latter procedure may, however, not always prove conclusive and may reasonably be supplemented with an investigation with an isotope It is the specific accumulation of radioiodine by the goiter that makes it possible to determine the presence of extrathyroidal *goiterous tissue*

A negative result from an isotope investigation does not necessarily exclude the presence of a goiter as the growth may not accumulate iodine to any appreciable degree Scanning methods however will enable a goiter to be found and its size, shape and localisation to be determined They will also show whether the tissue is of an extrinsic character or is connected with the thyroid gland in the neck (2, 3)

Profile measurements were carried out in all cases before thyroid scanning Scintillograms were obtained 24 hours after the administration of 100 μC of I^{131} with the aid of a tracerscanner SC 65 with a 19 hole 'honey comb collimator, a 2 × 2 inch NaI/Tl *crystal, and a single channel spectrometer* with a window at 364 keV

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FROM THE ROENTGEN DEPARTMENT (DIRECTOR PROF J FRIMANN DAHL), ULLEVAL HOSPITAL OSLO, NORWAY

POSITIVE CONTRAST MEDIUM IN PERFORATED ULCERATION

by

J FRIMANN DAHL

It is generally recognized that the diagnosis in cases of acute abdomen should be effected if possible by conventional roentgenography This in many cases must be supplemented with examinations performed with a contrast medium A barium sulphate emulsion has usually been found to be satisfactory and its employment is firmly established this particular method has been especially valuable in cases of obstruction for instance as well as in acute pancreatitis and acute regional enteritis (LAURELL 1930 KOCH 1944 FRIMANN DAHL 1960) It has however been avoided in many countries on the grounds of safety although it would appear to the writer that the method is indispensable and no harm has occurred in thousands of cases

The introduction of a new contrast medium Gastrografin, has not changed the principle but has made it possible to use a positive contrast medium in lesions such as a perforated ulcer Barium emulsion was previously administered only occasionally in cases of perforated ulcer when these were thought to be cases of obstruction When the subject is examined only in the supine position very little contrast medium will lie outside the stomach or duodenum in the

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Case 2 Female aged 64 who had undergone subtotal strumectomy in 1956 for nodular goiter with hyperfunction Circulation insufficiency in the form of arrhythmia and edema had persisted

On clinical and roentgen examinations there was no evidence of the thyroid in the cervical or intrathoracic regions A scintillogram (Fig 2), however revealed remnants of thyroid tissue in the right lower cervical region and at the level of the thyroid cartilage on the left side At the latter site, thyroid tissue 85 × 30 mm in size was connected with the tissue in the neck The collection of iodine was uniform Further roentgen examination including tomography, failed to confirm the findings

The scanning technique will ordinarily disclose the presence of an intrathoracic goiter although a negative result does not necessarily exclude the presence of thyroid tissue The method should be employed in conjunction with roentgenography when conventional examinations fail

SUMMARY

Two cases of intrathoracic goiter previously undetected in the clinical and roentgen examinations were found in a material of 150 cases in which scintillograms were obtained The value of the method is discussed

ZUSAMMENFASSUNG

In einem Material von 150 Fallen die mit radioaktivem Jod untersucht wurden, konnten 2 Falle mit intrathorakaler Schilddrüsenvergrosserung entdeckt werden die weder klinisch *noch rontgenologisch bemerkt wurden Der Wert der Methode wird erortert*

RÉSUMÉ

Deux cas de goitre intrathoracique qui n avaient pas été détectés auparavant par les *examens cliniques et radiologiques ont été découverts dans une série de* 150 malades examinés par scintigraphie Les auteurs examinent l intéret de cette méthode

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Fig 1 Perforated duodenal ulcer after barium emulsion per os in a case of probable obstruction



Fig 2 Perforated duodenal ulcer after aspiration and installation of Gastrografin through an indwelling tube

Conventional studies The diagnosis of a perforated ulcer is based on an *indirect sign* the demonstration of free gas in the peritoneal cavity In our latest series of 102 perforated ulcers a pneumoperitoneum could be shown in 82 per cent of the cases This figure varies from 70 to even 90 per cent in the literature probably depending on the degree to which the examination is pressed We feel that it is advisable to treat the patient as quickly and gently as possible and with a no touch technique even if some small gas bubbles should escape detection It was stated in 1948 that in about 10 per cent of cases an ulcer of the stomach or duodenal cap could be identified by gas in the niche (FRIMANN DAHL) Direct demonstration of a perforated ulcer of the stomach or the first part of the duodenum is usually best made by laying the patient on the left side so that the air collects in the pyloric region where about 90 per cent of all perforations are situated It may occasionally happen that the ulcer also becomes evident when the patient is placed erect but this position is not used as a routine Re examination after aspiration may show a pneumoperitoneum which was not apparent in the first films Gas is evidently sucked in or swallowed during the procedure and passes into the peritoneal cavity Careful inflation of the stomach with air as suggested by various authors may likewise increase the number of cases of pneumoperitoneum but the diagnosis may still be negative and a fistula and penetrating crater will not always be shown by this method

abdominal cavity (Fig. 1). However, in such cases the diagnosis can readily be made and the case can be dealt with as a surgical emergency. The small amount of barium emulsion that has escaped can at the operation be sponged up immediately. The employment of a positive contrast medium in acute abdominal conditions is therefore not new, or rediscovered merely because a water soluble contrast medium has been introduced. But, this contrast medium has one specific indication which is new, it can be used deliberately in perforated ulceration and may be administered despite the fact that it may enter the peritoneal cavity. The writer has found that this medium possesses no advantages over the conventional barium meal in bleeding ulceration, and that it is inferior to the latter in cases of pancreatitis or obstruction, because the mucosal pattern is affected more and more as the passage of the medium through the intestine proceeds.

The use of water soluble contrast medium (Gastrografin) in acute abdominal disorders has been advocated earlier, inter alios by MOORE (1955) and SAMUEL (1960) who used it not only in perforations but in hemorrhage, pancreatitis, and obstruction as well.

JACOBSON et coll. (1961) have presented a series of 120 cases of perforated ulceration. They used Hypaque 50 % which they administered through an indwelling tube. Supine and semi erect roentgenograms, including spot films, were obtained in rapid sequence and the authors maintain that by means of this examination a more exact grouping of the cases could be made, and more of the cases could be treated conservatively.

Gastrografin is a water soluble iodine containing contrast medium, the base of which is Urografin 76 % combined with a wetting agent, flavoured and sweetened with saccharin. The medium, which is relatively expensive, is resorbed from the peritoneal cavity within a few minutes. The reaction of the peritoneum to Urografin was carefully checked, in a series of 200 hysterosalpingographies, by GROSSMANN & REISS who concluded that it is the least harmful and most satisfactory contrast medium at present available. TOSCH examined the resorbtion of Gastrografin from the intestinal tract with labelled ^{131}I and stated that not more than 2 per cent of the dose was reabsorbed. STECKEN et coll. (1961) examined the intestinal reaction to various amounts of the medium and recommended a dose not exceeding 30 to 40 ml pure Gastrografin because a higher dose may provoke mild colic and frequent stools; they concluded that the medium should not be used in cases of gastroenteritis. Allergic reactions were not observed. The wetting agent has been added to obtain a better mucosal pattern by increased miscibility as well as speedy transit. This may be of some advantage particularly in examinations of the small bowel if this contrast medium is mixed with a barium emulsion but otherwise the necessity of a wetting agent appears questionable. It should be added that any tri iodized water soluble medium may be used for the examination of the intestinal tract.



Fig 5 Spot film prone position of large duodenal ulcer with small leakage



Fig 6 The contrast medium having escaped into the peritoneal cavity lies in the right lower flank after 5 min

too much forwards because the sinus of the stomach particularly in long stomachs may cover the pyloric area It is usually better to have the patient inclined somewhat dorsally However, the ulcer is often situated on the anterior wall of the duodenal cap and then the contrast medium escapes into the peritoneal cavity more easily when the patient is turned forwards (Fig 4) There is a considerable margin between the best position for the leakage to occur and for its demonstration in the films We have tried to solve this by first turning the patient forwards for some moments and then turning him more dorsally when the exposure is made If there is only small leakage spot films should be taken with slight compression (Fig 5)

The amount of contrast medium to be administered is estimated from the size of the stomach in the survey film If for instance the stomach is short and obliquely placed no more than 10 to 30 ml are needed whereas if the stomach is long and atonic 40 to 50 ml may be required only rarely is as much as 100 ml required After he has drunk the Gastrografin the patient is placed on the right side and films are taken shortly afterwards the contrast medium will flow along the lesser curvature down to the pylorus and will then pass through the perforation up under the liver and down to the flank (Fig 6) The direction of the leakage varies a great deal, it sometimes passes upwards and at others more obliquely downwards or straight down towards the flank (Fig 7) This depends upon the position of the ulcer and the duodenal bulb and their relations to the subhepatic ligaments



Fig 3 a) Supine gas under the anterior abdominal wall (fluid level in the stomach) b) Supine vertical projection 60 ml Gastrografin Duodenal ulcer leakage uncertain

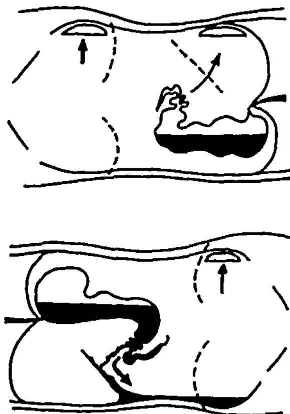


Fig 4 Drawing showing reversed conditions in perforated ulcer in left and right decubitus position horisontal projection

Technique with positive contrast medium The examination of perforated ulcers with a positive contrast medium calls for a reliable roentgenographic technique Preliminary survey films should be obtained in the supine position with vertical and horizontal projections and the left side down One of the films may be taken with the subject semi erect Films in the upright position appear to be unnecessary The contrast medium is readily miscible with the gastric contents but it is advisable to aspirate the stomach if the preliminary film reveals abundant fluid, otherwise dilution may prevent observation of detail It is naturally important to use as little contrast medium as possible

The patient is examined in the horizontal position only, and the first film is obtained supine The ulcer may occasionally be fairly well shown in this position (Fig 3) The second and more important film is taken in the right lateral decubitus position with a horizontal beam The patient should not be turned



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Fig. 3. a) Supine: gas under the anterior abdominal wall (fluid level in the stomach). b) Supine, vertical projection. 60 ml Gastrografin. Duodenal ulcer, leakage uncertain.

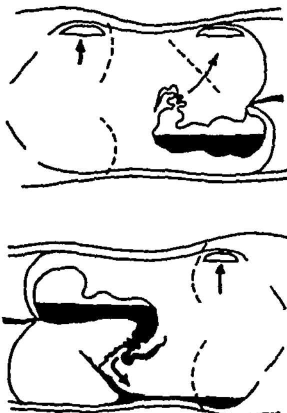


Fig. 4. Drawing showing reversed conditions in perforated ulcer in left and right decubitus position, horizontal projection.

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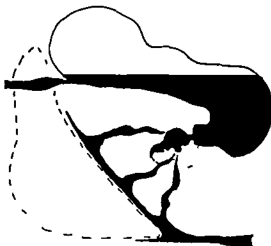


Fig 7 Schematic representation of different directions of leakage



Fig 8 Duodenal perforation evident after 50 ml Gastrografin per os contrast medium present along right lower flank

In the presence of leakage, and the contrast medium passing outside the stomach, the condition will be shown immediately, but in some few cases further films are required at 2, 5, and 30 min, and even at 1 hr (Fig 8) In such cases one must constantly bear in mind that the observation time should not be unnecessarily prolonged The films should generally be taken as soon as possible after the oral administration, because good results are not obtained if too

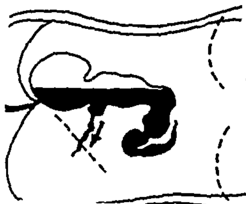


Fig 9 Drawing to show perforation of a gastric ulcer in ? the lesser sac

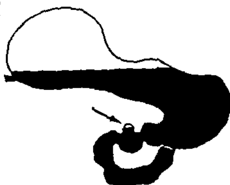


Fig 10 Fluid level in niche indicates a penetrating ulcer (No perforation or sealed perforation)

much of the medium has passed down into the small intestine The contrast filled loops may in the lateral decubitus position sink down and cover the right flank

Own investigations The material consists of 30 cases of perforated ulcers, all with a positive diagnosis and the findings were confirmed at operation or by the clinical course In the same period Gastrografin was given in 25 cases which showed no signs of perforation and proved to have other lesions For comparison it is also of interest to note that in the same space of time (2 years) 93 cases were examined with a pneumoperitoneum due to a perforated gastric or duodenal ulcer Gastrografin has been given primarily in cases of probable perforated ulceration but with no demonstrable pneumoperitoneum However this happened only in 4 out of 25 cases and the examination made the diagnosis definite where all other methods had failed It was also possible to demonstrate the leakage and the site of the ulcer The contrast medium in cases of perforation is visible along the lower surface of the liver in the flank, and at times in the lesser pelvis If the ulcer is situated on the lesser curvature the contrast medium may flow into the lesser sac (Fig 9) A penetrating ulcer on the lesser curvature (or posterior wall of the duodenal cap) may contain a fluid level in the niche and this will indicate that the ulcer is not perforated, gas and fluid cannot collect in a niche if there is a defect at its base (Fig 10)

In the presence of a small pneumoperitoneum and with the patient in good condition the administration of Gastrografin would appear to be indicated the situation of the ulcer and the degree of leakage are obviously of paramount importance Should however the pneumoperitoneum be marked and the clinical evidence of perforation leave little doubt the installation of Gastrografin can hardly be justified In cases of pneumoperitoneum arising from e g



Fig 11 Perforated ulcer on the anterior wall of the duodenal cap with fistula and contrast medium in the flank

fulminating sigmoiditis, a water soluble contrast medium is probably indi to exclude a perforating ulcer In cases of appendicitis as well, in whicl *differential diagnosis is difficult*, Gastrografin may be used to exclude a forated gastric or duodenal ulcer

Discussion

The reliability of the examination was shown in our series by the good relation between the presence of a pneumoperitoneum and contrast mec in the peritoneal cavity A pneumoperitoneum was evident in one case, there was no contrast medium apparent outside the gastro intestinal t and the correct diagnosis was revealed when a sealed ulcer was found on anterior wall of the duodenal cap In another case there was abundant fluid in the peritoneal cavity, but no pneumoperitoneum, and no cont medium lay outside the stomach or duodenum The explanation was found sealed perforation with reabsorbtion of gas and marked peritoneal react *In a further case a long fistula was revealed both in the 'gas study films an* gastroroentgenology with Gastrografin (Fig 11)

SUMMARY

The use of positive contrast medium in the examination of selected cases of perfora ulceration is discussed The conventional roentgenology of the acute abdomen is survey and the indications and advantages of the supplementary method are considered

ZUSAMMENFASSUNG

Die Verwendung von positiven Kontrastmitteln bei der Untersuchung von gewissen Fal von perforierten Geschwüren wird besprochen Es wird eine Übersicht über die konventione Roentgenologie des akuten Abdomens gegeben und eine Betrachtung über die Indikation und Vorteile der hier besprochenen Untersuchungsmethode angestellt

RÉSUMÉ

L'auteur étudie l'emploi de moyen de contraste positif pour l'examen de cas sélectionnés d'ulcère perforé. Il rappelle l'examen radiologique simple des syndromes abdominaux aigus et discute les indications et les avantages de cette méthode complémentaire.

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HEPATIC CALCIFICATIONS

By

B G KARRAS, A H CANNON and B ZANON JR

Intra abdominal calcifications are frequent radiographic findings Calcification occurring in the kidneys, pancreas, gallbladder and lymph nodes seldom causes diagnostic difficulties The rarity of hepatic calcification and the lack of information on this subject makes interpretation of these calcifications *more difficult It is first necessary to exclude surrounding organs as the site of* the calcifications This can usually be accomplished by positioning, pyelography and other localizing studies Some hepatic calcifications are easily recognized Multiple small discrete nodular foci of calcification may occur in the liver and spleen in tuberculosis and other granulomatous diseases Hemangiomas may show extensive calcification in a circumscribed area with streaks radiating from the center (2) Cystic calcification occurring in the liver and other *abdominal organs is usually associated with hydatid or other benign* cysts, but may also occur in other entities, including malignant lesions (4, 12) If the hepatic calcification is unlike the above types, the determination of its cause will likely be difficult because of the rarity of occurrence and the scarcity of reported cases

The purpose of this paper is to present eight cases of less common hepatic calcifications Attempts to find similar cases in the literature revealed meagre information upon this subject It is hoped that the cases presented will aid others in the differential diagnosis of hepatic calcification Awareness of some

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Fig 1 Case 1 A-p view of abdomen Amorphous calcifications with a carcinoma of the liver (bile duct type) Spherical calcifications in calculi lying in dilated ducts

of the less common disease which may cause calcification, and knowledge of the radiographic appearance of these lesions may enable the radiologist to render a more valid interpretation

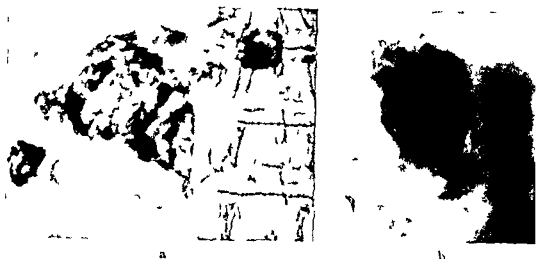
Case reports

Case 1 A 65 year old white male entered Chicago Wesley Memorial Hospital complaining of extreme weakness increasing abdominal distention and intermittent painless jaundice For 4 months he had had intermittent attacks of chills and fever Physical examination jaundice abdominal distention and ascites The liver was enlarged 5 cm below the right costal margin and was slightly tender

Radiographic examination of the abdomen revealed several peculiar calcifications lying beneath the right leaf of the diaphragm within the substance of the liver Several of the calcifications (Fig 1) were spherical in nature and resembled calculi Inferior to the spherical calcifications was an amorphous collection of calcium with fairly sharply defined borders

Following laparotomy the patient expired Autopsy revealed the more significant changes to be in the liver The right lobe had an irregular surface and cut sections revealed grayish tissue interspersed in the liver substance In some areas this tissue radiated along the bile ducts The bile ducts were irregularly dilated cystic and filled with friable material and multiple irregular calculi Microscopic examination revealed a moderately well differentiated seromucinous adenocarcinoma of the liver (bile duct type) with extension to the hepatic vein and gallbladder The carcinoma contained small amorphous irregular calcifications

Case 2 A 69 year old white female entered our hospital with intermittent pain and discomfort in the upper abdomen of two years duration She had had intermittent attacks of nausea and vomiting for the past five years Physical examination was negative except for right upper quadrant tenderness and minimal hepatomegaly



a b

Fig 2 Case 2 A p and lateral views of abdomen Several large sharply circumscribed intra
calcifications within gummata of the liver

Radiographic studies revealed a non functioning gallbladder and a large irregular
fication in the right upper quadrant localized to the liver The calcification (Fig 2) was
and fairly homogenous and consisted of a large mass and two smaller calcific deposits

Because of continued symptoms and the non functioning gallbladder an explo
laparotomy was performed Large irregular nodules studded most of the surface of the
The upper one third of the entire right lobe of the liver contained a nodular type of in
tion with areas of scarring and some fissuring The gallbladder was diseased A cholec
tomy was performed and biopsies were taken from involved areas of the liver The path
diagnosis of the gallbladder was chronic cholecystitis The gross appearance of the
resembled multiple gumma formations and microscopic sections were compatible w
granuloma

Further questioning of the patient revealed that in 1927 she had a lesion of the cervix w
was diagnosed as primary syphilis For the following decade she was treated with h
metals Serology was positive on several occasions but had been negative for some years
positive evidence of syphilis and the gross and microscopic findings suggestive of gu
formation make the most likely diagnoses of this case calcification in hepatic gum
or hepar lobatum

Case 3 A 61 year old white male was admitted to our hospital with the chief complai
epigastric pain *increasing in severity over the past four to five months*

The pertinent physical findings revealed the liver to be enlarged three finger brea
below the costal margin

Films of the abdomen revealed a calcification in the right upper quadrant which was c
in nature (Fig 3) No filling of the gallbladder could be obtained at cholecystography G
eralized Paget s disease was present

The laboratory findings included a prothrombin time of 45 % a thymol turbidity of
units and an alkaline phosphatase of 38 units Icteric index was 13 The acid phosphates
0 55 units

An exploratory laparotomy was performed A large mass approximately 4 cm in diame
was found imbedded in the inferior aspect of the liver The mass was pale white in color a
firm On incising the mass it was found to be a large abscess containing considerable purul



Fig 3 Case 3 Abdominal film Large circumscribed calcification in the wall of an hepatic abscess

material The gallbladder was partly contained within the mass The abscess cavity arising in the liver was limited by the gallbladder mesentery and pericolic fat The wall of the abscess cavity was hard and calcified The gallbladder wall was also found to be thickened and when opened contained multiple stones The gallbladder gallstones and a stone in the distal end of the common bile duct were removed the abscess cavity was drained Microscopic sections of the gallbladder revealed marked chronic cholecystitis with some calcification in the wall of the gallbladder *E coli* and gamma streptococci were cultured from the purulent material

This is a case of calcification occurring within the wall of an hepatic abscess partially bounded by the gallbladder The wall of the gallbladder was partially calcified but the calcification was mainly within the abscess cavity wall Subsequent films of the abdomen showed this calcification still to be present

Case 4 A 53 year-old white female was admitted to our hospital with the chief complaint of passing mucous and blood in her stools for the past 3 months She had anorexia, vague abdominal discomfort and considerable weight loss

Barium examination of the colon revealed an area of narrowing in the sigmoid colon which was interpreted as a carcinoma of the colon

Laparotomy disclosed a carcinoma of the sigmoid colon with multiple metastases to the liver vaying from 1 to 4 cm in size A segmental resection of the sigmoid colon was *performed*

Eight months later the patient began to develop right upper abdominal discomfort The liver was enlarged to below the umbilicus and was hard and nodular The patient was treated with 5 fluorouracil with subjective improvement but two months later developed back discomfort Films of the spine and abdomen showed a large area of stippled calcification in the



Fig 4 Case 4 A p film of abdomen Diffuse finely granular poppyseed calcifications in diffuse metastases from carcinoma of the colon

liver All previous films were reviewed and it was found that the patient s initial gallbladder study showed a small area of stippled calcification in the liver On subsequent films this increased in size and in some areas there was coalescence of the calcification (Fig 4)

The patient expired 26 months after her initial symptoms Autopsy showed widespread hepatic metastases Microscopic examination revealed a moderately well differentiated adeno carcinoma secondary in liver with focal calcification within tumor tissue

Case 5 A 53 year old white female was admitted to hospital with the chief complaint of right upper quadrant tenderness Physical examination revealed marked hepatomegaly An area of mottled *calcification in the liver was found at cholecystography* This area had a finely granular appearance (Fig 5) Barium enema showed an annular carcinoma of the transverse colon At surgery, extensive calcified metastases were found in the liver



Fig 5 Case 5 Finely granular calcification in the liver representing diffuse calcified metastases from carcinoma of the transverse colon

Case 6 A 45-year-old white female was admitted to the hospital with a 3 year history of carcinoma of the ascending colon At surgery a local resection had been performed Current examination revealed marked hepatomegaly Roentgen examination of the abdomen showed a finely granular calcification in the liver This calcification was identical in appearance with the other cases of metastatic colonic carcinoma previously described

Case 7 A 65-year-old white male with severe back pain Four years prior to his admission to our hospital he had an abdominoperineal resection for adenocarcinoma of the recto-sigmoid colon with local metastasis and 14 months before his admission he had a repair of an abdominal hernia At that time a biopsy of the liver showed metastatic carcinoma to be present

Physical examination on admission to our hospital disclosed the liver to be enlarged 10 cm below the left costal margin and to be hard and nodular Films of the chest (Fig 6) and abdomen showed a large area of poppyseed calcification in the liver There were also multiple pulmonary nodules present in the chest

Case 8 A 27 year-old white male was admitted to our hospital with the chief complaint of mild vague right upper quadrant pain unrelated to meals Thirteen years previously the patient had an enucleation for an ocular melanoma Two years later bilateral axillary metastases were removed

Physical examination was not remarkable A firm liver edge was just barely palpable All laboratory data was normal

At roentgen examination of the gallbladder stomach and colon several calcified areas were found in the liver (Fig 7) varying in size and nodular in configuration Some were densely calcified while in others only a rim or shell was calcified



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Fig 7 Case 8 A p film of abdomen showing nodular and shell like calcificat on scattered through the liver Metastatic melanon a

active and are seldom fatal No calcification occurred in any of the cases The gross appearance of the liver in our case of hepatic gumma was similar to the above description

Several cases similar to the case of calcified colonic liver metastasis have appeared in the literature WELLS (1956) reported 3 cases of calcified liver metastases In two of these three cases the primary lesion was in the sigmoid colon and in the third case presumably arose elsewhere in the colon APPLEBY (1958) reported 2 cases where the primary lesion was in the sigmoid colon in

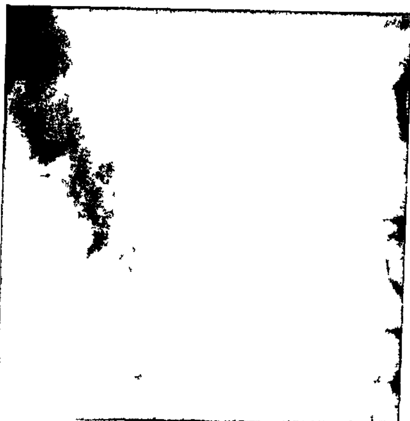


Fig 6 Case 7 Calcification of metastasis from carcinoma of the colon

arotomy, many nodules of varying sizes were found to be scattered over the surface er Two of these were excised
scopic sections of the excised nodules revealed a cystic structure composed of dense ous tissue containing moderate amounts of calcium surrounding a central lumen h typical pigment containing melanoblasts The diagnosis was metastatic melanoma er with areas of calcification Despite the evidence of distant metastasis the patient nued to live in fairly good health for an additional five years

Discussion

difficult to find descriptions or roentgen reproductions of calcified gummata, although several authors (1, 2, 3, 6, 7, 13) list this as a f hepatic calcification SYMERS et coll (1946) reported 19 cases of or multiple gumma in 102 cases of proven hepar lobatum Eighteen ses had splenic involvement and he states that calcium may be deposited lesions of the spleen
r (1953), in analyzing 66 cases of late syphilis of the liver, found deep scarring to be the most frequent findings These varied from minor to the typical hepar lobatum Gummas were present in 38 % of the id varied considerably in size He states that they are invariably in

Case 4 and Case 7 were previously reported as single case reports in the Northwestern University Quarterly Bulletin (9 10) Permission for their use in this paper has been granted

Acknowledgements

We wish to express our thanks to Dr Howard Burkhead and Dr John Fotopoulos of Evanston Hospital Association for the use of Cases 5 and 6 We extend special thanks and appreciation to Dr Earl E Barth for his assistance and help in the preparation of this paper

SUMMARY

Roentgenograms and case histories of seven patients with hepatic calcification are presented along with a review of the literature It is recommended because of the frequency of a serious etiologic cause that a reasonable effort be made to ascertain the etiology in all cases of hepatic calcification

ZUSAMMENFASSUNG

Die Radiogramme und Krankengeschichten von sieben Patienten mit Leberverkalkungen werden prasentiert und an Hand einer Literaturubersicht besprochen Infolge der grossen Zahl der Falle mit ernster Athiologie wird empfohlen diese in allen Fallen mit Leberver ka kung n zu erklaren

RÉSUMÉ

Les auteurs présentent avec une revue de la litterature les radiographies et les observations de s pt malades ayant des calcifications hépatiques Il est recommandé en raison de la fré quence de la gravité de leur cause de s efforcer de déterminer l étiologie dans tous les cas de calcifications hepatiques

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he case and in the ascending colon in the second case A similar case with the rimary in the sigmoid colon has also been reported from the Massachusetts eneral Hospital (5) SCHRODER (1959) presented three cases of hepatic alcification In one of the cases the calcification was from metastatic colonic arcinoma In this case, as in two of our cases, the hepatic calcifications made s appearance before the colon lesion was diagnosed The calcification, which ccurred in the liver secondary to metastases from the colon in these cases and our cases, was diffuse and finely granular In some areas there was coales ence of the calcification This calcification has been likened to 'poppyseed' alcification (9), and appears to be typical for colon metastases Careful adiologic inspection of the liver region should be performed whenever a olonic carcinoma is found, and if this calcification is seen first a thorough amination of the colon is warranted

Calcification occurring in primary carcinoma of the liver is a rare finding CHRODER reported a case occurring in primary bile duct carcinoma A re ew of the literature by SCHRODER disclosed five previously reported cases of lcification in hepatic carcinoma all occurring in children MARGULIS (1956) und calcification in 3 of 11 cases of hepatomas but gave no description of its ppearance BASSLER et coll (1947) reported 4 cases of hepatic calculi In one these cases the patient was jaundiced and was surgically explored A chole stectomy was performed Seven months later a growth in the scar was opsied and found to be metastatic adenocarcinoma The patient eventually ed without demonstrating the primary focus The radiographic findings and e tumor recurrence in the scar strongly suggested carcinoma of the liver

In general we feel that most physicians consider hepatic calcifications to be nign etiologically However, a malignant cause was present in five of our ses We feel that a reasonable effort should be made to ascertain the etiologic ctors of all hepatic calcifications

Conclusions

1 Eight cases of less common causes of hepatic calcification are presented, ng with their roentgenologic findings

2 The literature was reviewed and found to be sparse on this subject

3 In all cases of diffuse, finely granular 'poppyseed calcification of the liver, tastatic colonic carcinoma has been the etiologic factor

4 The liver area should be carefully screened for calcification whenever a cinoma of the colon is found

5 Multiple discrete nodular opacities should suggest either multiple metas es or hepatic calculi

6 In all cases of hepatic calcification a reasonable effort should be made to certain the etiologic cause of the calcification

FROM THE GRACE HOSPITAL (DIRECTOR R W DE BUSK), DETROIT, MICHIGAN, U S A

BARIUM EXAMINATION OF CECUM IN APPENDICITIS

by

LEO S FIGIEL and STEVEN J FIGIEL

In cases of suspected appendiceal disease in which the clinical findings are atypical the radiologic examinations are generally limited to attempts at a localization of the appendix by contrast examinations (either barium meal or barium enema) and efforts to correlate areas of tenderness elicited on clinical examination in the region of the appendix Attempts have also been made to infer the presence of appendiceal disease on the basis of so called secondary signs such as fixation, angulation kinking irregularity of the lumen of the barium filled appendix the presence of fecoliths or appendicoliths abnormal stasis of barium in the appendix and other findings At the best it may be stated that such evidence is of limited value and in many cases may be totally unreliable

Our routine utilization of compression techniques, and films obtained in various projections at the time of fluoroscopy, has resulted in our appreciation and demonstration of numerous defects in the ileocecal region many of which have special clinical significance Our knowledge of lesions in this area has also been extended by the use of high kilovoltage techniques

By a demonstration of characteristic deformities at the cecal base on barium studies of the colon with or without secondary roentgen manifestations of disease in the appendix the radiologist will be able to establish a diagnosis

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Fig 3 a) and b) Deformity of cecal base due to induration of the wall as a result of inflammatory changes originating in the appendix c) The cecal changes after insufflation of air The central component represents the appendiceal ostium Partial filling of small and beaded appendix

appendiceal stoma may in some instances cause an intrusion or a filling defect in the cecal lumen which becomes visible on barium examination of the colon An exact correlation of the radiographic and surgical findings will indicate the cause of this cecal defect and it is on the basis of this roentgen sign that we have been able to diagnose appendiceal inflammatory disease Actually a similar correlation exists in the demonstration of the so-called papillary or ampullary sign in the descending limb of the duodenum in cases of relapsing pancreatitis

The central component of the changes represents a partial filling of the appendiceal opening or stoma In some instances the appendix may be partly or completely filled with barium and may show obvious pathologic changes such as marked constriction of its lumen or conversely, in one case in our experience a considerable dilatation In almost all instances when the appendix was filled considerable irregularity of the lumen of the appendix was seen, as well as a marked narrowing Retained fecoliths were occasionally demonstrated

It is obvious that one must be familiar with the radiographic anatomy of this area as well as of the normal variations to be able to avoid the pitfalls of an erroneous diagnosis such as surgical intervention promised on an erroneous roentgenologic interpretation of normal variants or of an occasional normal



g 1 Schematic representation of the changes e to edema and induration of tissue surrounding appendiceal stoma in cases of ulcerative and idative appendicitis



Fig 2 Prominence of mucosal folds at the junction of appendix and the cecal base (Gerlach s fold) Normal variant Filling of normal appendix

appendiceal disease in many cases in which the clinical findings are vague atypical This is especially true in older patients in whom appendicitis may a treacherous disease, and in cases in which the administration of anti otics has modified the pathologic process and its clinical picture The decision operate obscure cases in which non surgical conditions are a differential con deration may be greatly influenced by the demonstration of such deformities

Obviously, the patient presenting classical, clinical and physical findings the "acute appendix" is an immediate surgical problem and not a subject r consideration in this paper In such cases contrast medium studies of the owel are generally contra indicated We have, however, administered barium emas to several patients with atypical clinical findings in whom acute opendiceal disease was subsequently proven In several of these cases we were ble to make a diagnosis of appendiceal inflammatory disease without pro ucing any complications We were thus helpful in deciding the need for mmediate definitive surgery

Inflammatory changes in the cephalic or most proximal portion of the appen x will in many cases be associated with inflammation of the cecal wall im ediately surrounding, or contiguous to the appendix (typhlitis) (This is a ommon observation clinically at the time of surgery, and is one of the major easons why some surgeons prefer not to invert the appendiceal base at the peration) The resulting swelling or induration of tissues surrounding the



a b

Fig 5 Case of acute suppurative and gangrenous appendicitis with perforation a) Defect at medial aspect of cecum and filling of a long appendix the lumen of which is markedly irregular (arrows) b) Later film Same findings as in (a) but terminal ileum is also outlined (arrow) Super or arrow indicates origin of ileum which is markedly narrowed with loss of mucosal folds (Operation The entire cecum appendix terminal ileum and retro-peritoneal area was involved in an intensely inflamed granulomatous mass)



a b

Fig 6 Case of acute and chronic appendicitis with a perforation half way down the appendix with a small abscess in the region The basal cecal defect is seen when the patient is rotated to maximally expose the deformity of the cecal base (b)



Fig 4 Case of acute suppurative appendicitis with perforation a) Basal cecal defect with massive induration of the appendiceal stump and the wall of the cecum b) Partial filling of small irregularly constricted appendix

physiologic circumstance, such as intussusception In some cases a correct *roentgenologic interpretation of a spontaneously reducible ileocecal or appendico colic intussusception* in a symptomatic patient will alert the surgeon to the possibility of encountering normal findings at the time of surgery, and thus may force him to plan the operation accordingly

This paper represents an attempt to illustrate the roentgen manifestations of induration of the appendiceal stoma, as well as some of the typical and atypical appearances of lesions presenting major problems in the differential diagnosis in the adult, such as ileocecal intussusception, appendicocolic intussusception, polypoid lesions, and others

Filling defects at the cecal base, demonstrated at barium enema examinations, may be produced by a variety of entities, not all of which are necessarily pathologic or clinically significant Such defects must be evaluated and differentiated on the basis of their appearance on one or more barium examinations, since the constancy of such defects is one of the most important considerations in their differentiation It is also of great importance to evaluated defects at the cecal base on the premise of their appearance before and after expulsion of the barium enema, in addition to obtaining perfectly profiled radiographic studies of any suspected defect, since many situations such as minimal degrees of ileocecal intussusception, or appendico colic intussusception can be diagnosed



Fig 9 a) Commonly occurring defect due to invers on of the appendiceal stump at surgery b) Much larger cecal defect due to inversion of the append ceal stump This patient had vague right lower quadrant symptoms



F g 10 D fo mity of the cecum due to mucocele of append which may occa. onally cause ntussuscept on Class cal peripheral or egg shell calcif ca t on associated with a deformity of this type should ind cate the p esence of append ceal mucocele

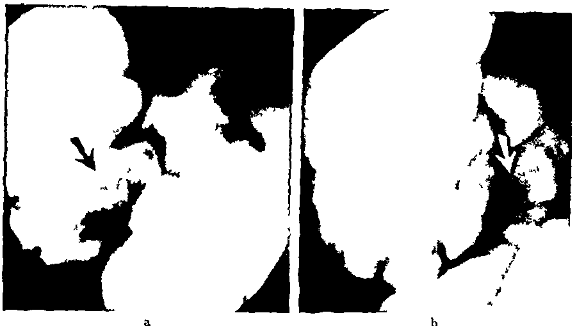


Fig 7 Case of suppurative appendicitis with perforation at the mid portion of the appendix and a small abscess a) Prominent basal cecal defect on barium enema examination thought to be due to inflammatory changes in the cecal wall due to appendicitis b) Re examination 6 days later Disappearance of cecal deformity and partial filling of appendiceal lumen which is markedly narrowed and very irregular

a b

Fig 8 a) Typical central indenture of the cecal base indicating probable retro cecal appendix b) Filling of retrocecal appendix when the patient s right side has been elevated



Fig 9 a) Commonly occurring defect due to inversion of the appendiceal stump at surgery b) Much larger cecal defect due to inversion of the appendiceal stump This patient had vague right lower quadrant symptoms



Fig 10 Deformity of the cecum due to mucocele of appendix which may occasionally cause intussusception Classical peripheral or egg shell calcification associated with a deformity of this type should indicate the presence of appendiceal mucocele



Fig 11 a) Basal cecal defect due to appendiceal intussusception The patient was asymptomatic b) Disappearance of the defect on second barium enema examination one week later Filling of a small atrophic appendix

only by such a comparison In the evaluation of filling defects of the cecal base the most important clinical information available relates to the presence or absence of an appendix, i e if the appendix has been removed The presence of a palpable mass is not generally a consideration in the type of case we will discuss Tenderness, *if present, may be a helpful finding*

A polypoid filling defect at the cecal base, in a patient in whom the appendix has been removed, is generally attributed to inversion of the apendiceal stump Prolapse or intussusception of an inverted appendiceal stump has been described in the literature and, therefore, the size and constancy of such a defect, *during one or more examinations, would be important in determining the possibility* of such an occurrence (Fig 12) When the appendix has not been removed, and a localized concave or polypoid defect in the cecal wall is demonstrated, one must consider numerous possibilities, i e induration of the appendiceal ostium with or without granuloma formation appendiceal granuloma or abscess, appendiceal *or ileocecal intussusception, retrocecal* appendix, ameboma, endometrioma in the female, carcinoma of the cecum, appendiceal mucocele, pressure from a contiguous structure or mass and, possibly, other conditions

Minimal degrees of ileocecal intussusception or appendico colic intussusception will produce deformities *which may disappear on manipulation (manually*



Fig 12 (a) Prominent cecal defect (arrows) due to intussusception or prolapse of inverted appendiceal stump (b) Marked decrease in size of defect during the later stage of the same examination The findings were reproduced on a second examination

or with a pressure cone) or expulsion of the enema Such defects will very frequently not be reproduced on a second examination Relationship of the cecal base to the pelvic or iliac crest on comparison of pre and post vacuation barium examinations is helpful in the evaluation of such defects Identification of the appendix on the expulsion film and disappearance of the basal cecal defect should suggest an appendiceal intussusception although ileocecal intussusception may produce a similar deformity (Figs 11 and 13)

Appendiceal granuloma or abscess may produce a variety of defects generally easily recognizable Large granulomas and abscesses will usually displace the terminal ileum as well as produce cecal deformity In some cases intestinal gas in the right lower quadrant will suggest abscess formation Absence of the psoas outline associated with a mild scoliosis to the left may occasionally be present Almost always a palpable mass will be present Tenderness will usually be present when there is an active inflammatory process The WBC will usually be elevated with a shift to the left In certain cases with granuloma formation especially in patients having received antibiotics a clinical diagnosis of neoplasm is not uncommon even at the time of surgery Such lesions are generally differentiated rather easily in the radiologic examination



Fig. 13. a) Deformity of the cecal base due to prolapse or intussusception of ectopic ileocecal valve (confirmed at operation). b) Normal contour of cecal base on expulsion study and partial filling of appendix (previous appendectomy). Appendico colic or ileo cecal intussusception suggested.

Appendiceal mucocele may be diagnosed if a typical laminated calcification is seen in the right lower quadrant. Mucoceles may produce shallow defects at the cecal base due to extrinsic pressure, and occasionally, may produce intussusception at the cecal base.

SUMMARY

In many cases, in which the clinical findings are vague or atypical, the demonstration of characteristic deformities at the cecal base on barium examination of the colon due to edema or induration of tissue surrounding the appendiceal stoma with or without secondary roentgen manifestations of disease of the appendix will permit the establishment of a diagnosis of inflammatory disease of the appendix. The differential diagnosis of numerous basal cecal deformities, physiologic and pathologic, are discussed and illustrated.

ZUSAMMENFASSUNG

In vielen Fällen, bei denen der klinische Befund unbestimmt oder atypisch war, gestattet die Darstellung der typischen Deformität des Cecums mittels Bariumeinlauf die Diagnose eines entzündlich veränderten Appendix. Die Diagnosestellung gründet sich auf das Vorhandensein von *Oedem* oder Induration des Gewebes, das die Appendixbasis umgibt. Die Differentialdiagnose von Deformitäten der Cecumbasis, sowohl physiologische als auch pathologische, werden besprochen und illustriert.

RÉSUMÉ

Dans de nombreux cas ou les signes cliniques sont vagues ou atypiques l examen baryté du colon mettant en évidence des déformations caractéristiques de la base de caecum dues a l oedeme ou a l induration des tissus qui entourent l abouchement de l appendice avec ou sans signes radiologiques secondaires d affection appendiculaire permet de poser le diagnostic d etat inflammatoire de l appendice Les auteurs discutent le diagnostic differential des déformations de la base du caecum physiologiques et pathologiques et en donnent des exemples

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THE NEPHROGRAPHIC EFFECT IN RENAL ANGIOGRAPHY WITH SODIUM IODIDE

An experimental study in dogs

by

N P G Edling and C O Ovenfors

The present investigation was concerned with the phenomenon of the angionephrographic effect in selective renal arteriography after injection of a diffusable inorganic salt sodium iodide The concentrations of the salt that once were used for aortography in man are too hypertonic for selective injection and cause an abnormal angionephrographic effect due to severe vascular disturbance (Edling *et coll* 1959) Examinations have been performed in dogs with low concentrations of sodium iodide to study its unobstructed passage through the kidney and with lowering of the arterial blood pressure an angionephrographic effect has been produced

Edling et coll studied the angionephrographic effect produced by the injection of organic iodine compounds and thorium dioxide in selective renal arteriography in dogs The course and degree of the phenomenon differ with these two agents and depends upon the ability of the water soluble organic compounds to pass the renal barrier while the colloidal thorium dioxide suspension remains intravascular

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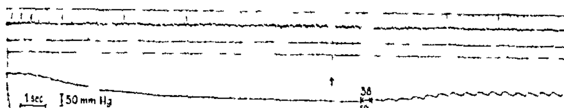


Diagram of registration of the mean pressure in the lumbar aorta of a dog The arterial blood pressu was lowered to about 30 mm Hg by increasing the intrabronchial pressure by means of an oxyg *injector connected to the intubated dog The arrow marks an exposure*

Method

The dogs were kept under superficial general anaesthesia For the inductio 0 5 to 0 7 ml pentothalsodium 5 % (Abbot) (thiomebumal sodium) plus 0 1 to 0 12 ml nembutal 6 % (Abbot) (pentobarbitone sodium) per kg bodyweigh were given, and for maintenance 1 to 2 ml pentothalsodium were administere when necessary The *media were injected intravenously in a hindleg*

The catheterizations were performed percutaneously in both femora arteries, and red Ödman catheters were introduced into the aorta or the rena arteries, guided by image intensifier fluoroscopy

For initial localization of the origins and courses of the renal arteries, 1 m Urografin 45 % (sodium methylglucamine diatrizoate) per kg bodyweigh was injected into the aorta at the level of the second lumbar vertebra, and single films obtained Preliminary aortography with rollfilm was performed after the injection of 1 ml Urografin 45 % per kg bodyweight

Urografin 4 6 % was injected on one side, simultaneously with sodium iodide 2 3 % on the other, both in amounts of 1 5 ml per kg bodyweight, after bilateral selective catheterization of the most proximal parts of the renal arteries *A sodium iodide solution of 2 3 % is iso osmotic with the plasma*, and 4 6 % Urografin has approximately the same roentgen density as 2 3 % NaI The selective injections were repeated in each dog with the sides changed

The arterial blood pressure of the dogs was lowered to about 30 mm Hg when the selective injections were started (see Diagram), and was accomplished by increasing the intrabronchial pressure by *means of an oxygen injector* (NORDENSTROM) connected to the intubated dog The blood pressure was restored to ordinary level as soon as the injections of the contrast media were completed

Special tests were performed in order to establish that the Urografin 45 %, injected at the initial aortographies, was not the cause of the angionephro graphic effect that appeared after the selective injections The arterial blood pressure was lowered after three aortographies, and single films then exposed after 30 and 45 minutes, without any sign of an angionephrographic effect An interval of at least half an hour between the separate examinations in each experiment was allowed to elapse In addition, Urografin 4 6 % and *sodium* iodide 2 3 % were each injected selectively, after blood pressure lowering

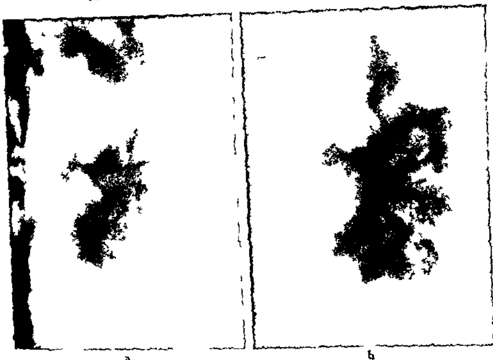


Fig 1 Selective catheterization of the left renal artery in a dog and injection of 30 ml NaI 2 3 after lowering of the arterial blood pressure a) Contrast filling of interlobar arteries and commencing angionephrographic effect b) Angionephrographic effect and contrast filling of interlobar and renal veins

without any previous contrast medium injection and an angionephrographic effect was obtained Lastly a second renal aortography was performed to restudy the condition of the kidneys after the selective injections

The contrast medium injections were performed with the Gidlund H P injection syringe (Elema) in the renal aortographies Selective arteriographies were carried out manually The injection time in the first case was about 4 seconds and in the second case, 15 to 20 seconds The speed of manual injections were kept equal on both sides Repeated checks of free blood flow through the catheters were made in order to obviate the risk of occlusion of the renal arteries by the selective catheterization and to allow superfluous medium to run off into the aorta during the injections

The films of the aortographies and selective arteriographies were obtained with the aid of a Gidlund automatic film changer (Elema) The program for the aortographies was 1 exposure/sec for 2 seconds 0 5 exposure/sec for 10 seconds and 0 1 exposure/sec for 60 seconds and for the selective arteriographies 0 5 exposure/sec for 12 seconds, and 0 1 exposure/sec for 60 seconds In both programs three further films were obtained at 2, 3 and 4 minutes after the injections

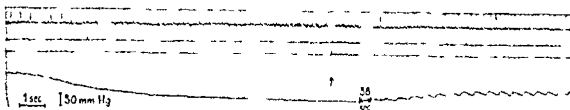


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Fig 3 Selective catheterization of the left renal artery in a dog and injection of 30 ml Urografin 46 after lowering of the arterial blood pressure Exposure after the pressure had been restored 2 min after the injection Fading angionephrographic effect with filling of the collecting tubules in the pyramids

The filling of the main arteries was generally very poor in the selective injections of the kidneys with lowering of the arterial blood pressure It was however of about the same degree of density with both media The interlobar arteries between the pyramids were sometimes better outlined (Fig 1a) The accumulation of both contrast media started simultaneously and a diffuse fairly homogenous density of both kidneys occurred (Fig 2) After the arterial blood pressure had been restored to normal level there was a simultaneous general fading of the accumulation of both media The interlobar and renal veins were sometimes clearly demonstrated (Figs 1b and 2) The organic compound outlined the pyramids (Fig 3) in some kidneys while such filling of the collecting tubules was not obtained with sodium iodide In the kidney in which only the upper of two arteries was injected the nephrographic effect was of lower density than that of the other kidney

The angionephrographic effect and the excretion of the kidneys were normal at the final renal aortographies

The condition of the dogs was good and they behaved in a normal way during the period after the experiments

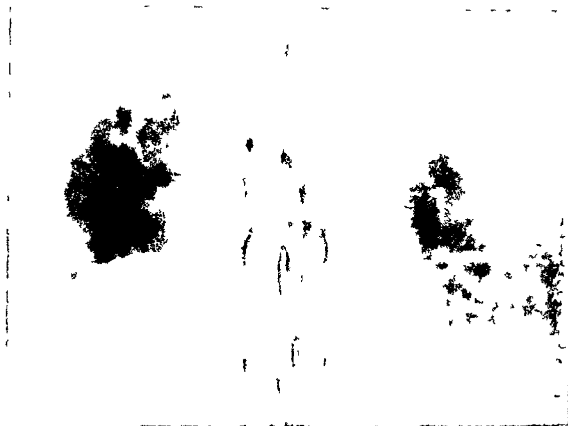


Fig 2 Selective catheterization of the renal arteries in a dog and injection of 30 ml Urografin 46 % in the right and 30 ml NaI 2 3 % in the left vessel after lowering of the arterial blood pressure Fairly homogenous angionephrographic effect of the same degree in both kidneys in addition poor filling of interlobar and renal veins

No test of renal function was performed apart from the study of the course of the angionephrographic effect

The dogs were kept alive for a period ranging from about 3 days to 6 weeks after the experiments and then killed by exsanguination The kidneys were removed and prepared for microscopic examination

Material The examinations were performed in 6 healthy dogs of two to three years of age and of weights ranging from 20 to 25 kg The organic iodine compound and the sodium iodide were each injected in 12 kidneys The right renal artery in one dog was double and the injections were made into the upper artery probably supplying several dorsal segments

Results

The angionephrographic effect in both kidneys at the preliminary renal aortographies had a normal course and density in all dogs, and the contrast filling of the pelves and ureters occurred normally

the urine Some evidence also exists from animal experiments that at least a part of the sodium appearing in the urine may be secreted by the tubules (DE WARDERER 1958), and it is known that iodide may be excreted by the non glomerular kidney (SMITH 1951)

According to these suggestions also the inorganically bound iodine may be arrested in its tubular transport by a fall in arterial blood pressure Both media may thus be accumulated in the tubular cells and produce a nephrographic effect, despite different mechanisms in the renal transport

When the arterial blood pressure falls to a level of 30 mm Hg the rate of renal blood flow is low and the contrast medium is no longer carried away by the blood stream Despite the low concentrations of the media used the vascular filling may be assumed to contribute to the increase in density of the kidneys, as is evident by the outlining of interlobar vessels (cf Fig 2) Further support for this assumption was found in comparative experiments with thorium dioxide in low concentrations It was found that the increase in density was due to the summation of the contrast medium present in the vessels, since thorium dioxide is neither filtrated nor excreted by the kidneys It was obvious from the histologic examinations that no cellular disturbance due to osmolarity occurred during the passage of the contrast medium

The tubular re absorption of the iodine ions explains why the contrast filling of the pelvis is much poorer with sodium iodide than with the organic iodine compound The latter is both filtered and excreted by the tubules but not re absorbed

SUMMARY

An experimental study of the angionephrographic effect in dogs after selective injection of sodium iodide into the renal artery is reported By using a concentration of the electrolyte iso-osmotic with the plasma and by lowering the arterial blood pressure it was possible to produce the phenomenon without gross disturbances of renal function by the compound used

ZUSAMMENFASSUNG

Es wird uber eine experimentelle Studie des nephrografischen Effektes an Hunden nach selektiver Injektion von Natriumjodid in di Arteria renalis berichtet Durch Verwendung einer dem Plasma iso-osmotischen Konzentration und Senkung des arteriellen Blutdruckes war es moglich dieses Phanomen ohne grossere Beeintrachtigung der Nierenfunktion zu erzeugen

RÉSUMÉ

Les auteurs présentent une étude expérimentale sur l effet angionéphrographique sur des chiens après injection sélective d iodure de sodium dans l artère rénale En employant une solution de concentration en électrolytes iso-osmotique a ec le plasma et en abaissant la tension artérielle il est possible d obtenir l effet néphrographique sans perturber beaucoup la fonction rénale

The results of the histologic examinations will be reported in a paper on the risks of selective catheterization of the renal artery No changes attributable to the contrast media were observed

Discussion

A normal angionephrographic effect at the initial and final renal aortographies suggested that there was no severe renal failure when the experiments started and after they were completed (Edling et coll 1959) In addition, the excretion of the compound into the pelves was also normal This gross assessment of renal function seems adequate having due regard to the purpose of the experiments

We avoided irritation or injury of the renal tissues due to osmolarity by using a sodium iodide solution iso-osmotic with the plasma at the selective arteriographies The amounts of iodine in Urografin 4.6 % and sodium iodide 2.3 % simultaneously passing the renal tissues may have been different In the concentrations of Urografin and sodium iodide used, the iodine contents in the former is slightly larger than in the sodium iodide, however, in testing the solutions in vitro, there was no difference in the absorption capacity as judged by visual assessment of the films Furthermore, it is of course not possible to determine the amount of the contrast medium that is constituting a reflux and running off into the aorta This difference should be of no importance, however, as each kidney in each animal was injected with both media Finally, no consideration was given to the difference in protein binding of the two compounds in the plasma This combination with protein is however rapidly reversible, and in principle it is counter balanced before the blood emerges from the capillaries (Smith 1951) The statement that in the selective renal arteriographies the angionephrographic effect in both kidneys appeared with about the same degree of density also indicates a roughly equal amount of iodine in the renal tissues

As the arterial blood pressure decreases to a level (60—70 mm Hg) corresponding to absence of glomerular filtration pressure, the organic iodine compound accumulates as a result of tubular function In our experiments it was found that an accumulation also of the inorganic compound occurs In the excretion of electrolytes we are dealing with paired ions and the iodine ion must be accompanied by a cation Due to the great amount of sodium ions after the injection it is probable that the iodine will be conditioned to the sodium particularly since the concentration of other cations in plasma are small even in normal circumstances There is, according to Smith (1951), an approximate proportionality between the glomerular filtration rate and proximal tubular re-absorption of sodium with approximately 80 % being reabsorbed The evidence is that the re-absorption of sodium is a primary active operation and the iodine anion is therefore carried with it and the major part is not lost in

FROM THE DEPARTMENT OF RADIOLOGY (DIRECTOR L. L. ROBBINS) OF MASSACHUSETTS GENERAL HOSPITAL, BOSTON, U. S. A.

MASTOCYTOSIS OF THE GASTROINTESTINAL TRACT

Report of a case

by

MURRAY L. JANOWER

The diagnostic roentgenologist's association with dermatological conditions is usually limited. Attention was recently directed to urticaria pigmentosa by several reports with positive roentgen findings in the skeletal system (3, 8, 9, 10, 13). Excepting occasional instances of duodenal ulcer (4, 6), no other roentgen abnormality has been described in this disease. The purpose of this paper is to document the first known instance of widespread positive roentgen findings in the gastrointestinal tract.

Case report. This was the third hospital admission of a 56-year-old white female with a chief complaint of abdominal pain and diarrhea of 16 years duration. A diagnosis of urticaria pigmentosa had been made 25 years previously. The patient had undergone a cholecystectomy in 1943 and a hysterectomy in 1945 with no relief of symptoms. The pain initially had been located in the upper abdomen with radiation to the back, but approximately six years prior to admission she had noted the onset of crampy lower abdominal pain followed by as many as 5 to 7 bouts of watery diarrhea. These episodes recurred at irregular intervals mostly without provocation but could be precipitated by ingestion of alcohol.

Physical examination was unremarkable except for the typical skin rash of urticaria pigmentosa. Numerous laboratory tests were performed and results consistent with a slight degree of intestinal malabsorption were found.

Submitted for publication 15 February 1962.

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a b

Fig 1 a) Thickened rugal folds in stomach and abnormal proximal small bowel b) By one hour the entire small bowel was seen to be abnormal

An examination of the upper gastro intestinal in 1945 was stated to have been normal and a barium meal with a small bowel study in 1957 was reported as showing changes suggestive of regional enteritis (no films were available)

Roentgen examination of the upper gastro intestinal tract was performed and is discussed below An exploratory laparotomy was undertaken following the unusual and abnormal roentgen findings A jejunal mucosal biopsy revealed lesions identical with those found in the skin in urticaria pigmentosa

Radiographic findings The rugae of the stomach were thicker than normal (Fig 1a) In addition there was the suggestion of small nodular defects measuring less than 3 to 4 mm in the fornix The first portion of the duodenum was normal Beginning with the second portion the mucosal folds of the small bowel were thickened up to 4 mm in width and depth (Fig 1b) Uniformly studding these folds were multiple small nodular defects ranging in size from 2 to 4 mm (Fig 2) These changes especially the nodular defects were present throughout the entire small bowel, but were most marked in the jejunum The small bowel was normal in calibre and the barium reached the colon in one hour

A roentgen examination of the colon was hindered by a large quantity of retained feces but revealed no gross defects during filling On the post evacuation film the mucosal folds seemed slightly thickened and several small nodular defects similar to those in the gastric fornix were suspected

Differential diagnosis As shown in Fig 2, this was a most distinctive small bowel pattern Sprue and other deficiency pattern diseases were ruled out by the absence of segmentation, barium flocculation, spasm, hyperirritability,



Fig 2 Magnified film of a segment of jejunum revealing the absence of normal mucosa and multiple small nodules.

and the moulage sign (5) Regional enteritis was excluded by the failure to find constant narrowing and the absence of fistula formation and stenotic areas (7) Other diseases in which skin lesions and multiple nodular defects in the bowel co exist were considered The patient clinically did not have ma lignant melanoma (7) or lymphoma (12) The nodules in Kaposi s disease (11) are usually larger and more sporadic This case conformed to no known pattern

Discussion

Urticaria pigmentosa is a rare skin condition characterized by yellow or brown macules or nodules which when irritated by vigorous rubbing undergo wheal formation (1) Microscopic examination of sections from the pigmented areas reveal conglomerations of mast cells which when stimulated release heparin and histamine (2) The skin reaction is secondary to the action of these substances

The biop y specimen in our case revealed similar nests of mast cells which showed a marked decrease in histamine concentration following alcoholic stimulation in vitro It was suggested, therefore that the nodular defects in

the bowel mucosa were mounds of mast cells, while the cramps, pain, and diarrhea were secondary to histamine release Antihistaminic agents are being tried to see if they will alleviate the symptoms

SUMMARY

Mastocytosis of the gastro intestinal tract in a case with urticaria pigmentosa which allowed excellent correlation of histologic physiologic and roentgen findings is described The mucosal folds were thickened and studded with innumerable small nodules measuring up to 4 mm in diameter The small intestine was most involved but also the stomach and colon revealed abnormalities Further roentgen studies of patients with urticaria pigmentosa are recommended

ZUSAMMENFASSUNG

Mastocytosis des Magen Darmtraktes in einem Fall von urticaria pigmentosa mit guter Korrelation der histologischen physiologischen und rontgenologischen Befunde wird beschrieben Die Schleimhautfalten waren verdickt und ubersat mit unzahligen kleinen Knotchen *von bis zu 4 mm Durchmesser Der Dunndarm zeigte die grobsten Veranderungen, Ventrikel* und Kolon zeigten aber auch Abnormitaten Weitere Rontgenstudien an Patienten mit urticaria pigmentosa werden empfohlen

RÉSUMÉ

L auteur décrit une mastocytose du tube digestif dans un cas d urticaire pigmentaire permettant d *établir une excellente corrélation entre les signes histologiques fonctionnels et* radiologiques Les plis muqueux étaient épaissis et parsemés d innombrables petits nodules mesurant jusqu à 4 mm de diamètre C est l intestin grêle qui était le plus atteint mais l estomac et le colon présentaient aussi des anomalies L auteur souhaite que les malades atteints d urticaire pigmentaire soient l objet de recherches radiologiques

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BOOK REVIEWS

ROENTGENOLOGY OF INTRACRANIAL MENINGIOMAS By Sidney P Traub 238 pages 128 illustrations and 18 tables Charles C Thomas Springfield, Ill, 1961 Price $ 14

This is described as a monograph on the roentgenology of intracranial meningiomas and is said to bring together all types of roentgenologic changes in meningeal tumors The author has reviewed the clinical records and roentgenograms of 170 cases of a material of 220 cases of intracranial meningiomas treated at the Montreal Neurological Institute during the period 1934—1953 Ordinary skull films were obtained in all 170 cases and in 32 of these basal views were included Air studies were available for analysis in 146 cases The text gives no indication of the extent to which encephalography or ventriculography was performed although 12 of 13 investigations of olfactory groove meningioma were carried out by means of the latter procedure Angiography probably of the carotid artery was performed in 7 of the 170 cases *Reproductions of roentgenograms from other hospitals have* been used to illustrate certain angiographic changes

It is understandable that with such a material the author has concentrated on the interpretation of conventional skull films and this aspect is dealt with in almost 100 of the 220 pages of the book (angiography occupies 15 pages 3 of which are text and pneumoencephalography covers 37 pages 6 of which are text) Changes evident in ordinary skull films are comprehensively and beautifully illustrated although this appears to be routine material and to contain nothing that is new The author claims that it is difficult to differentiate between middle meningeal arterial and middle meningeal venous enlargement and that such a differentiation is of no practical importance the less specific term middle meningeal groove enlargement has therefore been chosen It is true that the middle meningeal artery groove and the groove for the corresponding dural veins (the bregmatic veins) follow more or less the same course but it would appear to the reviewer that it is important to differentiate between them Widening of the arterial groove most often in combination with a wide foramen spinosum invariably indicates a highly vascularized lesion (a meningioma or more rarely a vascular malformation), whereas the groove of the accompanying veins varies in width within wide normal limits It is possible in most cases to differentiate between these two kinds of grooves the arterial groove having inter alia a more tortuous course A wide middle meningeal groove in a case of a meningioma of the wing of the sphenoid is described as being caused by the tumor, the reason for which is hard to understand especially as there is no mention of verification by angiography operation or autopsy As meningiomas of the wing of the sphenoid are as a rule rather sparse in vessels and as most of them seem to be drained basally it is a priori improbable that they should cause an enlargement of the middle meningeal groove

LINDGREN *in his study* of temporal tumors has shown that it is often possible to differentiate between a meningioma and an intracerebral tumor from changes in an air filled temporal horn The same is true if to a lesser extent of tumors in other situations Meningiomas because of their extracerebral origin and their sites of predilection cause a fairly typical displacement and deformation of the ventricular system Local irregularity of the ventricular system on the other hand, indicates an intracerebral lesion Examination of the cisterns and the subarachnoidal space *is an important* part of an air study particularly in extracerebral tumors The outlining of a tumor by subarachnoidal gas is the best way of proving that it is extracerebral These fundamental facts are hardly mentioned in the somewhat incomplete description contained in the encephalographic chapter It would appear from the legends to the illustrations that the author is not wholly familiar with the difference between the encephalographic changes produced by direct tumor effect and those caused by displacement of the lateral ventricle under the falx

Descriptions of meningiomas dating back to the seventeenth century are given in a fairly comprehensive historical review and many of these are quite interesting Short notes on the clinical signs caused by meningiomas in various locations may also claim the attention of radiologists The list of references is not complete and several papers of the last ten years especially European contributions to angiography are missing The worth of the book lies in the excellent illustrations of the changes produced by meningiomas as evident in ordinary skull films But this is definitely not a monograph on the roentgenology of intracranial meningiomas

Sture Stattin

Le petit cancer de l'estomac Par J Massa 116 pages et 77 figures Masson Paris 1961 Price 27 NF

The early diagnosis of cancer of the stomach is discussed in this monograph The earliest change consists in superficial erosion of the mucous membrane and local infiltration with rigidity of the mucosal folds A correct roentgen diagnosis can only be obtained by a careful examination of the mucosal pattern and with the stomach filled with contrast medium The book contains a large number of roentgenograms and photographs of operation specimens collected from the literature

Folke Knutsson

ATLAS DER ANGIOKARDIOGRAPHIE ANGEBORENER HERZFEHLER Von Ralph Kunzler und Nikolaus Schad 224 Seiten 91 Abbildungen Georg Thieme Stuttgart 1960 Price DM 85

The justifications for this book are indicated in the preface It is stated that no comprehensive work on angiocardiography has been published in the German language and that no attempts have yet been made to present the angiocardiographic phenomena as characteristic appearances showing the nature and degree of an anomaly

The historical and technical aspects are considered in the second chapter While the authors make praiseworthy efforts to present the subject matter in a concentrated form they do not always make clear distinctions between the technique and the material and equipment which they themselves employ and those which must now be relegated to the past Nowadays only water-soluble organic iodine compounds are used as contrast media for cardioangiography but the authors mention four media which belong to the iodopyracet sodium iodomethanate and sodium acetrizoate groups and which are much more toxic than the sodium diatrizoate preparations now available

Great attention is paid to the technique in heart catheterization and several illustrative diagrams of different typical positions for the catheters are given

Following a description of the normal anatomy and of what the authors call diagnostic criteria in the pathologic angiocardiogram the main congenital malformations are presented individually In connection with the description of coarctation of the aorta an illustration is included in which retrograde catheterization via the external carotid artery with injection of contrast medium into the aorta was performed in a young child it should have been explained that this technique is hardly a routine measure as angiographic investigation of coarctation of the aorta in children may be readily carried out by the injection of contrast medium into the pulmonary artery

The book in the main follows the generally accepted views Its concentrated text and well selected illustrations make it a useful preliminary guide for those wishing to obtain some information on this branch of roentgen diagnosis

Björn Nordenström

L Arthrose cervicale postérifure (étude anatomo radiologique) — The posterior cervical osteo arthritis (anatomical and radiological study) — Die hinteren Halsarthrose (Anatomische und Rontgenstudie) Par S De Sèze A Djian C Wellinger et J Leroy Iconographie — Supplément international des Monographies médicales et scientifiques , October 1960 — No 1 79 pages et 103 illustrations Dr Jean Garnier Paris 1960

This 'international supplement' is one of a series of medical and scientific contributions edited by Dr Jean Garnier and is a sort of 'picture book , many of the illustrations of which are reproduced about twice the normal size The first part of the book consists of 50 pages of basic information on the anatomy and radiology of the cervical spine as seen in common radiographic projections The second part of the book comprises 30 pages and deals with pathologic conditions

The schematic arrangement has been carried too far Much of the text makes somewhat *strange reading to a radiologist osteophytes at the lateral margins of the vertebrae are called* 'osteophytic overlap (in the German part osteophytische Ausschweifungen) and the term 'photograph for a roentgenogram or a reproduction of a roentgen film is not in conformity with current usage Too much space seems to have been devoted to relatively unimportant matters such as the differential diagnosis between laryngeal calcifications and changes in the vertebral column Various oblique views seldom used in clinical radiography are described in detail Questionable methods seem to have been employed for the depiction of the C1—C2 region and the authors present no illustrative examples Failure to show up the essential details is only too apparent in many of the illustrations and better results would probably have been obtained if *some form of contrast levelling had been used*

There appears to be no justification in recommending the monograph to radiologic libraries It should perhaps be added that the translation seems to leave a good deal to be desired

O e Mattsson

Die juvenilen Rückgratverkrümmungen Von Friedrich Wilhelm Rathke 156 Seiten und 122 Abbildungen Georg Thieme Stuttgart 1961 Price DM 23 60

This book offers a comprehensive review of the literature on the development and malformations of the vertebral column The author describes different theories advanced to explain juvenile scoliosis and kyphosis and endeavours to arrive at the biological cause of these curvatures He concludes that it is not static factors but a disturbance in growth of congenital origin that produces the deformity The work is of more interest to biologists than to roentgen diagnosticians

Folke Knutsson

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List of Supplements to Acta Radiologica

(Issued by November 1962)

For Suppl. Nos I—XXII inclusive see list issued by December 1960 in Vol. 54 fasc. 6. The information given therein is still valid.

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